

MAGILL'S CHOICE

Agriculture in History



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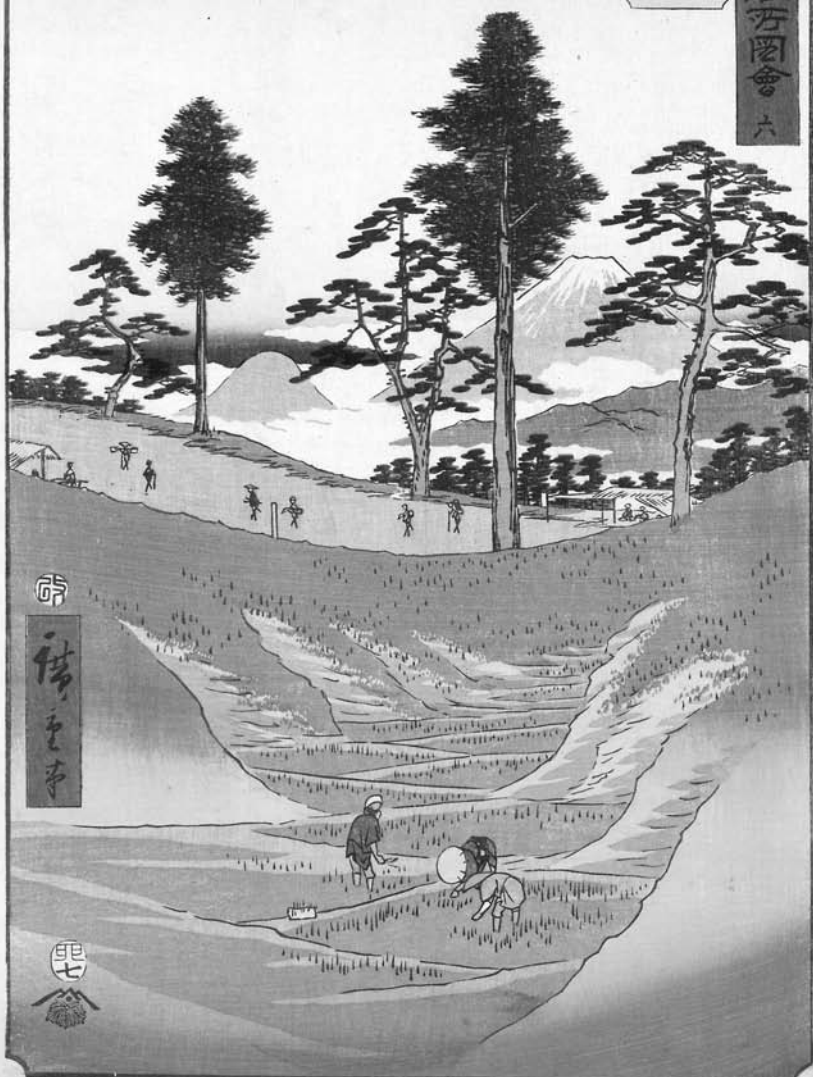
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MAGILL'S CHOICE

AGRICULTURE IN HISTORY

Volume 1

Prehistory-1747

from

The Editors of Salem Press

R. Kent Rasmussen

Project Editor

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Frontispiece: Mid-nineteenth century painting by Andō Hiroshige (1797-1858) showing Japanese workers in a rice paddy. Mount Fuji can be seen in the background. As in many East Asian countries, rice has long been the most important staple in the Japanese diet. (*Library of Congress*)

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■ PUBLISHER'S NOTE

It would difficult to name a subject more central to human history than food production. No society can survive without a reliable means of feeding its members, and every society's long-term survival rests upon its efficiency in doing that. The ability of human societies to grow and to develop into complex civilizations has always required the specialization of labor, which becomes possible only when some of their members are liberated from having to spend most of their time gathering and preparing food. Labor specialization requires agricultural systems efficient enough to free substantial numbers of people from food-production work so they can undertake other tasks, such as governing, building structures, and soldiering.

Whatever other goals societies have had, all have continuously sought to improve their agricultural systems by making them more efficient, diversifying their produce, and expanding their markets. These quests have been at the heart of political expansionism, voyages of exploration, and international trade and conflicts throughout world history. Moreover, the rapid expansion of the modern world's population—fostered by medical and dietary advances—has intensified the quests for more nutritious foods, improved crop yields, and more equitable distribution of food. All these issues and many more point up the importance of agriculture in human history. Surprisingly, however, comparatively little attention has been paid to this subject. The three volumes of Salem Press's *Agriculture in History* therefore help fill an important need in reference works by collecting essays on major turning points and developments in the long history of agriculture around the world.

SCOPE

Drawing most of its 171 articles from Salem's *Great Events from History* series, *Agriculture in History* covers a wide range of events and developments—from the origins of plant cultivation and animal husbandry in different parts of the world to innovations in techniques, the development of modern farming equipment, the introduction of chemical fertilizers, and experiments in the genetic engineering of food plants and animals. Other broad issues addressed in these vol-

AGRICULTURE IN HISTORY

umes include farm labor, land management, climatic challenges, famines, agrarian reform, and government farm subsidies. The articles are arranged in chronological order by the dates of their events.

Agriculture is generally understood to encompass all work involved in the cultivation of crops, the raising of livestock, and the preparation of plant and animal products for markets. *Agriculture in History* takes an even broader view of agriculture to encompass other forms of food production and aspects of human consumption of agricultural products. Eighteen articles discuss hunter-gathering societies, the immediate predecessors of settled agriculturalists in most parts of the world. Twenty-five articles address topics relating to human diets, nutrition, and cuisine and how they relate to food production and distribution.

The scope of *Agriculture in History* is both geographically and chronologically immense. A particular strength of the set is its emphasis on the origins of plant cultivation and livestock breeding. Volume 1 opens with a double-length essay on the rise of agriculture throughout the populated world as far back as the tenth millennium B.C.E. As the set's articles move forward in time, they treat the emergence and development of plant cultivation and animal husbandry in all the world's populated regions. They also account for major advances in technology and the spread of crops through different parts of the world. As the articles move into the modern era, the subject matter expands to encompass discussions of land and labor policies, scientific research, dietary issues, and environmental issues.

Agriculture in History is not a comprehensive history of world agriculture, but its articles touch on a remarkably large proportion of important world developments in food production. More than one-third of its articles concern agriculture in North America, but the rest provide generous attention to other regions in the world. For example, 36 articles focus on Europe; 19 on Africa; 30 on Asia, the Middle East, and Australasia; and 15 on Central and South America and the West Indies. Two address subjects affecting the entire globe.

Agriculture in History covers almost every aspect of human cultivation of food and fiber crops and the raising of poultry and livestock for human use. The set consequently includes articles on such subjects as the building of dams and canals for irrigation; the development of chemical pesticides to combat threats to plant life; horticultural

tural research; the invention of tools used for planting, harvesting, and processing agricultural products; the evolution of farm-labor systems; government efforts to foster agricultural production, manage land use, and oversee marketing; and the devastating impact of natural disasters on agricultural systems.

Among the historical questions that this set addresses are these:

- Who the earliest farmers in North America were
- How rice cultivation arose in China
- What edible plants and animals the New and Old Worlds introduced to each other
- How pastoralism spread through Southern Africa
- How tea drew Europe into trade with East Asia
- How scientific cattle breeding arose in Europe
- How mechanical inventions and chemical discoveries have revolutionized agriculture
- How some government attempts to manage agriculture have caused or worsened famines
- How advances in food processing have transformed agriculture
- How droughts and harsh weather conditions have threatened agriculture
- What new environmental hazards have been brought by chemical pesticides
- What the promises and perils of genetic engineering of crops and livestock might be

ORGANIZATION

Articles in *Agriculture in History* are arranged in chronological order, based on the dates assigned to their events. As in the *Great Events* sets from which they are drawn, these essays offer a student-friendly format. With a few exceptions, the essays are of roughly uniform length—about 2,000 words each—and almost every article is illustrated with at least one picture, map, or graphic.

The top matter of each article contains these ready-reference components:

- the most precise date, or date range, that can be assigned to the event
- a descriptive title that stresses the event's relevance to agricultural history

AGRICULTURE IN HISTORY

- a summary paragraph describing the event and encapsulating its significance
- the main locale of the event
- a summary list of agricultural issues addressed by the essay, ranging from “Agrarian reform” and “Agricultural education” to “Textile industries” and “Tropical produce” (an index to all these issues can be found at the back of volume 3)
- a key figures list providing the names, vital dates, and brief descriptors of people who played major roles in the event, when such can be identified

Following the top matter, the main text of every essay—after the opening essay, which surveys world agriculture—is divided into two subheaded sections:

- *Summary of Event* provides a chronological framework for the entire event
- *Significance* summarizes the event’s historical impact

Following the main text is a section subheaded “Further Reading,” which contains an up-to-date and annotated list of other published sources appropriate for students. The final subheaded section, “See also,” provides a selection of cross-references to other articles on related subjects within *Agriculture in History*.

BACK MATTER

Five additional finding aids are located at the end of volume 3:

- *Categorized List of Entries* lists article titles under the 42 different “Agricultural issues” appearing in the top matter of the individual articles; most articles are listed under at least three different issues
- *Geographical List of Entries* lists article titles under the names of more than 90 different countries, regions, and continents
- *Index of Personages* provides page references to all the names in key-figure lists as well as other persons discussed in the essays
- *Index of Foods, Plants, and Animals* provides page references to cultivated and gathered plant products and to raised and hunted animals that have been consumed and utilized by human societies.
- *Subject Index* incorporates the contents of the above two indexes as well as page references to hundreds of other subjects.

ACKNOWLEDGMENTS

As is the case with all Salem Press's reference work, these volumes would not be possible without the contributions of a large team of scholars. We therefore wish to thank, once again, the 139 scholars who wrote the articles appearing in *Agriculture in History*. We would also like to thank the vendors who have provided the nearly 200 photographs used in these volumes. We are particularly grateful to the fine photographers who have made their work available on Dreamstime.com.

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■ C. 10TH MILLENNIUM B.C.E.-10TH CENTURY C.E.

AGRICULTURE AND ANIMAL HUSBANDRY SPREAD THROUGH THE WORLD

Plant cultivation and controlled stock breeding increased human population density and resulted in the emergence of urbanism, occupational specialization, social stratification, writing, and long-distance trade in the ancient world. Agriculture also necessitated the development of metallurgy, engineering, astronomy, and mathematics and transformed both religious and political systems as humans altered the environment through deforestation, terracing, and irrigation.

LOCALE: Worldwide

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Hunting and gathering; Climate change; Ecology and environment; Migration; New crops and food products; Population growth; Subsistence agriculture; Tropical produce

SUMMARY OF EVENT

Archaeological evidence that attends humankind's great transformation from hunter-gatherer to agriculturalist includes pollen samples, vegetal remains, and animal bones. Art, writing, agricultural artifacts, and topographical modifications provide information on early farming systems.

Although the precise mechanism that led to domestication of edible plants remains unknown, models proposed to explain the transition from hunting and foraging to incipient agriculture emphasize climatic change, population growth, and accidental domestication. The domestication process began independently in the Middle East, Mexico, sub-Saharan Africa, eastern North America, South America, and eastern Asia. From these regions, techniques, cultigens, and animals diffused throughout the world.

MIDDLE EAST AND EGYPT

Domestication began in an environmentally diverse region, the Fertile Crescent, a rugged, naturally rich habitat. Distribution of wild ce-

reals, such as emmer and einkorn wheat and barley, and wild legumes, such as peas and lentils, paralleled the areas of earliest cultivation. Farming began in the Jordan Valley and spread into adjacent lands. By the eighth millennium B.C.E., autonomous villages had been established in areas occupied by modern Israel, Jordan, Syria, and Turkey.

By 8000 B.C.E., goats and sheep were being domesticated at Zawi Chemi Shanidar in modern Iraq, and wheat and barley were being cultivated at Aswad in Syria and Cayonu in Turkey. Peas and lentils may have been grown as early as the ninth millennium B.C.E. at Aswad. At Cayonu, pigs had been domesticated by 7000 B.C.E. Evidence of domesticated cattle has been secured from sites in Turkey and in southwestern Europe dating to 6500 B.C.E. Initially, cattle were used for meat and draft purposes. Agriculture was a powerful subsistence strategy within the Fertile Crescent by 7000 B.C.E. Gradually, knowledge and the artifacts of agriculture diffused into Crete, Thessaly, Egypt, and lowland Mesopotamia.

Early tools were simple. The digging stick, which has been used in hunting and foraging communities from time immemorial, was a primary tool. Sickles for harvesting cereals were constructed of chipped flint. Food-processing tools such as mortars and pestles were made of ground stone.

The Tigris and Euphrates floodplains were farmed after 6000 B.C.E. By 5500 B.C.E., irrigation canals had been constructed to move water from the rivers to field systems and to facilitate field drainage following spring inundations. Construction and maintenance of large irrigation works required a centralized political authority for effectively coordinating labor.

Intensive irrigation, along with the plow, allowed population to increase in the developing urban centers on the Mesopotamian plains. The plow, or ard, probably evolved from a digging stick into a wooden device harnessed to oxen and designed to scratch the surface of the soil. Such plows were in use by the late fourth millennium B.C.E. Figs, olives, and grapes were grown in the eastern Mediterranean lands during the fourth millennium B.C.E. The date palm was cultivated for fruit and wood on the Mesopotamian floodplains.

Farming variations emerged by 3000 B.C.E. in the Middle East and eastern Mediterranean. One pattern emphasized dependence on

rainfall for cereal cultivation and livestock raising. Another variant, centered in the river valleys, relied on irrigation. By the end of the first millennium B.C.E., canalization was accompanied by lifting devices such as the waterwheel. Such devices and practices persisted into the twentieth century C.E.

Egyptian food production practices were derived from the cereal and livestock economies of the Mesopotamian floodplains. Early farming communities were evident in Egypt by the sixth millennium B.C.E., and by 4000 B.C.E., agricultural practices had spread across the Nile Valley. In contrast with Mesopotamian irrigation techniques, Egyptian farmers employed a system of basins and sluices to regulate and divert floodwater to growing crops. The annual deposits of silt that remained after the floodwaters receded in the Nile and Mesopotamian floodplains enhanced the soil's fertility. However, the Mesopotamian hydraulic system carried an overabundance of salts, ultimately retarding the soil's fertility there. In contrast, in Egypt, the receding floodwaters cleansed the system, creating and maintaining high fertility levels for millennia.

EUROPE

The crops, animals, and culture of early farming diffused from the Middle East into Anatolia and the Aegean region. By the mid-seventh millennium B.C.E., cattle had been domesticated in Greece. Between 6000 and 4500 B.C.E., permanent farming villages were located over



Ancient Greek frieze suggesting the importance of cattle in Greek culture. (F. R. Niglutsch)

wide areas in the Balkans. By 6000 B.C.E., the cereal and livestock complex of southeastern Europe had spread up the Danube River and into central Europe.

Agricultural technology changed and adapted as it spread and moved into the European forests. The diffusion of agriculture along the Mediterranean and Atlantic coasts, as well as the penetration of northern Europe, required varied subsistence and technological strategies. Climate and altitude were crucial considerations. In some locales, hunting, fishing, and shellfish collecting remained important.

Cultivation within the forest zones required fire and stone adzes to clear dense wooded tracts. After an area was burned, seeds were sown in the nutrient-rich ash using simple tools. Slash-and-burn farming was a key technique in the evolution of European agriculture. By the fourth millennium B.C.E., people had harnessed the power of oxen, which combined with the simple ard (plow) to enhance efficiency. Early European farmers planted barley, wheat, vetch, flax, peas, beans, and lentils. Oats and rye were probably domesticated in Europe.

By 4500 B.C.E., the rising productivity of agriculture, coupled with the evolving social organization of populations, had resulted in the construction of elaborate tombs in Western Europe. The most enduring achievement of these agrarian societies, however, was their megalithic edifices, the greatest of which was Stonehenge (3100-1550 B.C.E.), located on Salisbury Plain, England.

Agriculture shaped economic foundations long before the appearance of the classical world. In Greece, implements remained simple and the general complex of cereals, fruits, and vine crops were cultivated. By the late fifth century B.C.E., mills had been constructed for pressing olives, and animals treaded stone floors to thresh grain. The Greeks wrote little on agriculture, but the Romans produced a broad literature on agricultural topics, covering topics such as soil fertility, farm management, and field procedures. To feed its great urban centers, Rome used slave power in tandem with numerous simple and mechanical wooden and iron tools. Cereals, olives, grapes, fruits, and vegetables moved from diverse environments along Roman roads and seaways.

European society in the early Middle Ages rested on an agrarian base. Manorialism evolved following the collapse of Roman adminis-

tration in the Western Empire (476 C.E.). Feudalism, the larger political and military framework that included manorialism, was based on a system of personal loyalties and territorial arrangements. Local landlords allowed peasants, or serfs, to reside in manorial villages and perform agricultural and other tasks in exchange for various services. Peasant agriculture in the post-Roman world was labor intensive, and physical mobility was circumscribed. Peasant life and work revolved around a religious and agricultural calendar.

Plowing and general hauling were accomplished with oxen. Northern European soils demanded a plow that would cut through the heavy soil and turn it over to facilitate drying. During the sixth century C.E., German and Slavic populations developed such a plow. Conservation concerns were manifested in the two-field system, which allowed one of a pair of fields to lie fallow and replenish its fertility. The two-field system, which by the mid-eighth century C.E. had become the three-field system, was based on growing winter cereals while allotting equal fallow ground. It was used in southern Mediterranean Europe, where inadequate moisture meant poor spring seedings.

In contrast to the market-oriented large Roman estates, the manors during the early Middle Ages strived for self-sufficiency. Perhaps 90 percent of the European population was directly involved with agriculture and manorial labor.

AFRICA

In contrast to other regions of the Old World, the evidence for the development and spread of agricultural practices in Africa is poor. Before the Saharan region was largely abandoned because of desiccation between around 2500 and 1000 B.C.E., millet and sorghum may have been domesticated between 4000 and 2000 B.C.E.

Vegeticulture, which is the cultivation of multiple species of plants within a single field, may have been practiced in West Africa by the fifth millennium B.C.E. Coffee was domesticated in Ethiopia, and millet, yams, sorghum, okra, African rice, and groundnuts were all cultivated in West Africa with stone tool technology. Plow agriculture was unknown until the nineteenth century C.E. Sub-Saharan Africa posed many ecological obstacles including diseases and poor soils, and tropical cultivators adapted in numerous ways over the millennia.

The general cereal crop complex diffused into North Africa from

the Middle East. In the forest zones, slash-and-burn was the foremost technique before tillage. As soil fertility ebbed, populations shifted and opened new forest tracts. Indigenous domesticated animals were few: guinea fowls, cattle, and perhaps donkeys. Evidence suggests cattle were domesticated in the Sahara region, perhaps by 4500 B.C.E. East African cattle culture is ancient, and pastoralism remained a major subsistence pursuit among tribes into the twentieth century C.E.

SOUTH AND EAST ASIA

Early food production in India is linked to the Middle Eastern and East Asian patterns of domestication. The site of Mehrgarh (c. 7000 B.C.E.) in modern Pakistan revealed evidence of the cultivation of wheat and barley. By 5500 B.C.E., the population in India and other parts of South Asia was extensively exploiting wild cattle, sheep, and goats, suggesting a predomestication period similar to that of the Middle East. By the end of the third millennium B.C.E., domesticated water buffalo, pigs, cattle, goats, and sheep were mainstays of village life. A millennium later, donkeys, camels, and horses, used in transport, were to be found over much of South Asia.

Few crops and animals were domesticated independently in India. The exceptions are chickens and cotton, which date from as far back as 5000 B.C.E. Dates, grapes, and seed plants such as sesame were probably grown by the third millennium B.C.E. Agricultural hand tools, such as the adze and ax, were simple and constructed of stone.

The dense urban populations of Harappā and Mohenjo-Daro, cities of the Indus civilization (c. 2500-2000 B.C.E.), were supported through farming. The supporting technology included engineering projects to control flooding of the Indus River. The plow is believed to have been introduced into India following the collapse of the Indus civilization. The livestock, crops, and technological complex of village India have persisted into the modern world.

Early northern Chinese agriculture focused on the cultivation of millet, whereas in southern regions, rice became a staple. By 6000 B.C.E., foxtail and broomcorn millet as well as Chinese cabbage had been cultivated at the northern site of Peiligang, and rice had been cultivated in southern China at Pengtoushan. Additional plants included fruit trees (peach, pear, and apricot), soybeans, and the bottle gourd. The mulberry tree was grown for silkworm raising. At

Agriculture and Animal Husbandry Spread Through the World

Hemudu (c. 5000 B.C.E.) in the Yangtze Valley, rice was cultivated, and stone, bone, and wooden agricultural tools were discovered. Livestock included pigs, chickens, cattle, goats, and sheep. Cattle were used for traction and probably pulled wooden plows for rice cultivation. The principal tools remained the hoe and spade. Fishing provided an important supplement for agricultural communities.

From these peasant villages evolved monumental Chinese civilizations. During the third millennium B.C.E., the Longshan culture in north China began to shift from extensive to intensive cultivation. Social differentiation, copper metallurgy, and specialized labor intensified, increasing the social complexity. In the second millennium B.C.E., the traditional agricultural economy enabled the Shang Dynasty (1600-1066 B.C.E.) to emerge, and people began to use the water buffalo. During the first millennium B.C.E., higher levels of efficiency were introduced into Chinese agriculture through the use of extensive irrigation works and iron implements, including the plow.



One of the earliest grains to be cultivated intensively, rice has long been the most important Asian staple crop, and farmers have learned how to maximize its production by utilizing every available piece of land. In many regions, this requires skillful terracing of mountainous terrain.
(PhotoDisc)

OCEANIA

Kuk swamp, Papua, in the New Guinea highlands provides the earliest evidence for agricultural activity in the Oceania region of the South Pacific: drainage systems, perhaps for sugarcane and taro cultivation, dating to 7000 B.C.E. This date suggests the possibility of another independent center for plant domestication in the world. By 4000 B.C.E., tree foods, coconut and perhaps sago, were used in the lowland Sepik Basin. Independently of these precocious developments, migrations from Southeast Asia, beginning about 1500 B.C.E., initiated colonization through the remainder of Melanesia, as well as Micronesia and ultimately Polynesia, including New Zealand. These migrations diffused the primary domesticated fauna, dogs, pigs, and chickens, in addition to the greater yam, sugarcane, and new varieties of bananas throughout Oceania.

Successful settlement of the Pacific Basin was based on continuous adaptation to environmental diversity. The mainstay of life, vegiculture, persisted into the historic period, accompanied by the tree crops of breadfruit, coconuts, and bananas. Ecological variability caused prehistoric populations to evolve varied exploitative systems: raised bed cultivation in swampy locales for yams; sunken fields for taro, designed to benefit from subsurface moisture; and hillside terracing and irrigation. Swidden, or slash-and-burn technology, remained the premier cultivation technique into historic times. Tools were simple: the digging stick, a mainstay of tuber horticulture, and adzes of shell and stone. In contrast to mainland Asia, Melanesian chiefdoms and the Polynesian civilizations followed a different evolutionary course based on sophisticated vegiculture, tree food cultivation, and the resources of the sea.

NORTH AMERICA

The native peoples of North America lacked the technology of the Old World civilizations, which included large animals for traction, metallurgy, and the wheel. A powerful energy base and a formidable subsistence technology evolved, however, permitting sophisticated adaptations, and in some environments, spectacular urban civilizations.

In the woodland regions of eastern North America, native populations domesticated a number of seed plants: lamb's quarter, goosefoot, and the sunflower. Sunflowers and squash were domesticated by



Late sixteenth century depiction of the Timucua people of Florida planting seeds with handheld digging sticks. (Library of Congress)

the mid-third millennium B.C.E. Hunting, fishing, and shellfish collecting supplemented wild food gathering and cultivation. Digging sticks and stone hoes were used in seed-bed preparation. Plants of ritual and economic importance diffused from Mexico. Tobacco and maize arrived in the Midwest by the second century C.E. Maize was a minor cultigen until the ninth century C.E.

An entirely different pattern evolved in the Salt and Gila River Valleys in the American Southwest. Rooted in the Mesoamerican tradition, the Hohokam (1-1400 C.E.) irrigated their fields in the hot Sonoran desert. Canalization, dated circa 300-200 B.C.E., included segments more than fifteen miles (twenty-four kilometers) long and irrigated thousands of acres. Hohokam agriculture included floodwater farming: These techniques allowed population expansion and political evolution. Large hydraulic works at the Snaketown site implied labor coordination, not only for construction but also for annual maintenance.

MESOAMERICA

In the regions of modern Mexico, Guatemala, and adjacent Central America, independent domestication took place. Plant species

were numerous, the foremost being maize, beans, squash, and chili peppers. Animal domesticates were few, consisting of the turkey and hairless dog. At Tehuacán in Mexico, maize was cultivated by 5000 B.C.E., chili peppers by 4000 B.C.E., and beans during the late first millennium B.C.E. Evidence of squash from Guila Naquitz in Oaxaca may date to 6000 B.C.E. By the fourth millennium B.C.E., villages in the Tehuacán Valley employed small-scale canalization. The shift to complete reliance on domesticates encompassed five millennia, a period in which hunting and foraging remained important. In the lowlands, the slash-and-burn technique was used to clear heavy vegetation; in the highlands, the digging stick remained the primary tool. Ground stone tools (the *mano-metate*) processed corn into meal.

Domesticates (particularly the triad of maize, beans, and squash) provided the nutritional base for Mesoamerican civilizations. The Olmec (c. 1200-400 B.C.E.) of the humid Gulf Coast farmed the rich soils adjacent to the lowland rivers. Teotihuacán (1-750 C.E.) in the central Mexican plateau became an urban center boasting a population estimated between 125,000 and 200,000 people. Irrigation was used selectively, as was *chinampas*, a form of raised field farming in which decomposing materials and mud are piled in a watercourse and secured by stakes and branches. After taking root, the branches and saplings held the “floating garden” firm.

In lowland Central America, a variant of shifting cultivation, *conuco*, was developed to grow such crops as sweet potatoes and manioc. The primary tool remained the digging stick, or *coa*.

SOUTH AMERICA

In pre-Columbian lowland and highland South America, regions with extreme ecological variability, emphasis was placed on root crops. Potatoes, manioc, quinoa, beans, peanuts, cotton, and oca are among the many plants that facilitated the growth of civilization. Domesticated fauna were limited to ducks, alpacas, llamas, and guinea pigs. Llamas and guinea pigs were domesticated by the fourth millennium B.C.E. Domestication enjoyed a significant time span in Andean South America: Potatoes, for example, were domesticated by the late third millennium B.C.E., cotton between 4000 and 1200 B.C.E., and beans by 5800 B.C.E.

Irrigation was widely used. In the Moche Valley of north coastal

Peru (first to seventh centuries C.E.), water was diverted for cotton, peanuts, beans, and other crops. Cultivation was by hand. Canals were constructed of mud and earth: Engineering was sophisticated to ensure the correct gradient of water flow down hillsides. Soil fertility was replenished through guano gathered from offshore islands. Moche intensive agriculture may have supported a population of 50,000. The Moche state was a heavily stratified, politically complex society, as evidenced by monumental building projects and an elaborate mortuary ritual. An equally complex agricultural infrastructure supported the sociopolitical hierarchy.

Rene M. Descartes

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SEE ALSO: c. 9500-c. 5000 B.C.E.: Syria's Abu Hureyra May Be Earliest Agricultural Settlement; c. 6500-c. 5000 B.C.E.: Nilo-Saharan Farmers Spread Cultivation and Herding; c. 6200-c. 3800 B.C.E.: Ubaid Culture Begins Mesopotamian Agricultural Communities; c. 5500-c. 4500 B.C.E.: Halafian Culture Advances Mesopotamian Agriculture; c. 4000 B.C.E.: Rise of Sumer Improves Mesopotamian Agriculture.

■ C. 9500-C. 5000 B.C.E.

SYRIA'S ABU HUREYRA MAY BE EARLIEST AGRICULTURAL SETTLEMENT

The large settlement at Abu Hureyra in northern Syria provided evidence of early peoples' transition from a sedentary hunting and gathering economy to one based on farming and livestock husbandry.

LOCALE: Northern Syria, east of Aleppo

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Cattle keeping; Hunting and gathering

SUMMARY OF EVENT

A portion of the large site called Abu Hureyra, 28.5 acres (11.5 hectares), was excavated in a salvage context during 1972 and 1973 by a team of British, American, and Australian archaeologists: A. M. T. Moore, G. C. Hillman, A. J. Legge, and their colleagues. Surveys suggested that the tell, or site, held promise for answering specific questions linked to the evolution of agriculture in the Euphrates Valley. Queries included the circumstances and chronology leading to domestication, the settlement pattern and construction techniques of the village, the attendant social and cultural changes, and specifics on the inhabitants such as health, ideology, and occupational specializations. The salvage excavation proved to be exceptionally rich in human burials, the remains of faunal and vegetal foods, architectural features, and artifact types.

The cultural history of ancient Abu Hureyra was the result of a long series of planned, coordinated projects. The site was originally selected about 9500 B.C.E. by hunters and gatherers who found the environment to be abundant in wild cereals, nuts, fruits, and a spectrum of fauna, particularly the gazelle, which was extensively hunted. This was a healthy population, enjoying high levels of nutrition. Presumably when yields of wild vegetal foods declined because of environmental changes about 9000 B.C.E., the population of Abu Hureyra began cultivating rye. The permanent settlement of pit houses numbered between one hundred and three hundred individuals.

C. 9500-C. 5000 B.C.E.

Archaeological work determined that Abu Hureyra 1 (9500-8000 B.C.E.) was succeeded by an intermediate period (8000-7400 B.C.E.) that witnessed a population decline, as well as reduced wild-plant foraging. Village construction shifted to timber and reed huts. Cultigens were expanded during the intermediate period to include several varieties of wheat, barley, and lentils.

Abu Hureyra 2 (7400-5000 B.C.E.) demonstrates a cultural and technological lineage that links it to the earlier settlement. However, during three continuous occupation stages (Abu Hureyra 2A, 2B, and 2C), the inhabitants built on previous adaptations and ultimately created a productive economy dependent on domesticated species. Archaeological evidence indicates that early in Abu Hureyra 2, both sheep and goats were domesticated. By c. 7000 B.C.E., the population increased to 2,500-3,000 people; by c. 6000 B.C.E., the village population rose to 5,000-6,000 individuals. Mud-brick, multiroomed, single-family, single-story houses, up to 68 square yards (82 square meters) in area were constructed in close proximity to one another. Some houses contained colored plastered floors.



The practice of sheep- and goatherding begun in the Middle East many thousands of years ago has continued into modern times. (Library of Congress)

The economy of Abu Hureyra 2 focused on cereal cultivation, in addition to lentils, peas, vetches, and beans. Gazelle hunting remained important until about 6300 B.C.E., when sheep and goat husbandry, long an economic pursuit, replaced it. Pottery was developed about 7500 B.C.E. Cattle and pigs were added to the list of domesticates, the former perhaps being used to pull a primitive tillage tool, the ard. With the possible exception of cattle as draft animals, agricultural labor was most likely accomplished with hand tools, such as the digging stick.

The social organization of the community gradually became more complex as new economic and domestic challenges arose. Cooperation and coordination of large-scale gazelle hunting, village planning and construction, mud-brick manufacture, the transportation of materials, and decisions on field preparation, harvesting, and pasturing animals were prerequisites for the successful adaptation and continuity of the village.

Complex ideology in the form of ancestor worship appears to have emerged at Abu Hureyra: Burials were placed beneath the floors of houses, with special attention given to some skulls, which were separated from the skeletons. Evidence suggests a multistaged burial ceremony in which significant reverence and veneration were channeled toward the deceased.

Economic responsibility was divided along gender lines. Mass killing of gazelles was probably accomplished by male cooperation, coordinated by some form of leadership. Degenerative changes and stress on female skeletons revealed the physical problems linked to prolonged grain grinding through the use of the quern. Hence role specialization emerged in the village.

Long-term residency of families in particular dwellings suggests some form of close-knit lineage organization. This cooperative unit would have facilitated domestic craftsmanship and enhanced productive capacity and the successful maintenance of an agricultural surplus, at least a millennium earlier than other Neolithic sites in the area.

The 1972-1973 excavations yielded artifacts that mirrored the economic pursuits of the village during the forty-five centuries of its existence. Bone, stone, and obsidian points, scrapers, grinding dishes, querns, and pestles used in milling were recovered as well as pottery.

C. 9500-C. 5000 B.C.E.

Environmental changes that led to increased temperatures and decreased rainfall and most likely declining soil fertility caused the villagers to abandon the settlement c. 5000 B.C.E.

SIGNIFICANCE

Abu Hureyra is without qualification one of the world's first, largest, and best-documented early farming sites. It clearly demonstrates the economic, technological, and cultural changes inherent in the shift from a hunting-and-gathering way of life to an economy based on early farming techniques.

Rene M. Descartes

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■ **C. 9000-C. 8000 B.C.E.**

COCHISE CULTURE FOSTERS AGRICULTURE IN AMERICAN SOUTHWEST

The Cochise culture of Arizona and New Mexico marked a significant advance in technology and lifestyle over the previous Desert culture.

LOCALE: Present-day Arizona and New Mexico

AGRICULTURAL ISSUES: Archaeological discoveries; Hunting and gathering; Native American agriculture; Subsistence agriculture

SUMMARY OF EVENT

The various prehistoric periods in the New World began and ended at different times in different locations. Moreover, most human remains and ancient artifacts have disappeared, with but a few scattered human bones, stone articles, and pottery fragments remaining. There are two principal scientific techniques for dating ancient artifacts: dendrochronology, which is the study of tree ring growth in wood samples, and radiocarbon dating, which measures the amount of the radioactive isotope carbon 14 in organic material. Both these methods, however, are subject to a certain margin of error, which increases over time. Therefore, the categories and dates that have been developed by scholarly research provide only a general structure for the study of the prehistoric cultures of the New World.

Archaeologists have proposed that the Paleo-Indian period of the Pleistocene era began evolving into the Archaic period sometime around 9000 to 8000 B.C.E., reaching its height from 5000 to 1000 B.C.E. There were five major Archaic cultures: the Old Cordilleran in the Pacific Northwest; the Old Copper culture in the Great Lakes region; the Red Paint People in New England and eastern Canada; the Desert culture in the Great Basin region of Utah, Nevada, and Arizona; and the Cochise culture, which evolved from the Desert culture and was centered in Arizona and New Mexico.

The Paleo-Indians of New Mexico and Arizona relied on big-game hunting and gathering wild fruits and grains for subsistence. When the mammoths, horses, camels, bison, and giant ground sloths that

c. 9000-c. 8000 B.C.E.



Modern Apache woman carrying a baby on her back while hoeing corn during the early twentieth century. Her ancient ancestors did not have metal tools and were more likely to work with small hand tools. (Library of Congress)

once found forage in the rich grasslands of the area disappeared because of the climatic change at the end of the Pleistocene period, the Archaic people of the Desert culture hunted smaller game such as turkey, rabbits, and deer, while continuing to harvest wild fruits and grains. In Danger Cave, one of the major sites of the Desert culture, archaeologists have found small stone points for hunting small animals as well as baskets woven from plant fiber. They also found millstones used to grind wild seeds and nuts into flour, which formed the basis for an unleavened bread that was cooked in a shallow basket placed on hot stones.

The first evidence of the Cochise culture was found in 1926 near the town of Cochise, Arizona, named for the nineteenth century chief of the Chiricahua Apaches. Carbon-14 testing dated artifacts found there to about 9000 B.C.E. Small stone points, baskets, and millstones similar to those from Danger Cave were found at this site. These millstones are called manos and metates and are similar to a

mortar and pestle; the metate is a flat stone with a depression in the center, while the mano is a round grinding stone held in the hand. In early Sulphur Springs and Chiricahua phases of their development, the Cochise were not yet farmers. Several millennia later, however, at Bat Cave, a site in west-central New Mexico dating from about 3500 B.C.E., archaeologists discovered a number of corncobs, almost 1 inch (2.5 centimeters) in length, from a cultivated primitive species. This indicates that the Cochise people, in the third or San Pedro phase of their development, had acquired the concept of planting crops for food rather than relying on gathering. From the cultures to the south, in Mexico, the Cochise also learned to grow squash and beans.

At this stage, the Cochise people also began building shallow pit houses, which were pits dug into the ground and roofed over with twigs and small branches. They continued to weave baskets from willow, yucca, and agave fibers, and they began to make small, crudely shaped clay figurines and vessels, which were fired in open-pit fires. Scholars have also determined that the Cochise imported shells from the Pacific coast.

SIGNIFICANCE

As the big-game hunters of the Paleo-Indian cultures vanished along with their quarry, the Cochise people learned to hunt smaller game and, more important, began to cultivate crops. About the same time, they also began to make pottery. This introduction of agriculture and pottery into the area north of Mexico, along with the building of simple shelters, also prompted the appearance of semipermanent villages, which resulted in the creation of more complicated social patterns. One of the most significant legacies of the Cochise culture was the cultivation of corn, which not only provided a stable food supply but also often produced a surplus for trade. All these developments influenced the Southwest cultures in the Formative period (1000 B.C.E. to 1500 C.E.), the most organized and prominent of which were the Mogollon (direct descendants of the Cochise), Hohokam, and Anasazi. These three cultures, shaped by agriculture, developed a village lifestyle that led to the further development of tools, arts, and crafts, especially basketry and pottery.

LouAnn Faris Culley

c. 9000-c. 8000 B.C.E.

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■ C. 9000-C. 7000 B.C.E.

NILO-SAHARAN PEOPLES DOMESTICATE CATTLE AND CULTIVATE GRAIN

Ancient Nilo-Saharan peoples are believed to have been the producers of the first African pottery and to have initiated the African domestication of cattle and cultivation of the grain sorghum.

LOCALE: Between the Red Sea Hills and the Nile River (modern Egypt, Sudan, Eritrea, and Ethiopia)

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Cattle keeping; Innovations; Population growth; Tropical produce

SUMMARY OF EVENT

Nilo-Saharan peoples can be defined as those populations who inhabited territory west of the Red Sea Hills up to the Nile River region in the period 9000-7000 B.C.E.

Nilo-Saharans were among the first food producers in the world. In particular they began to domesticate African wild grasses and to raise wild cattle, both of which could be sustained in the Red Sea Hills and in small pockets of the eastern Sahara. Nilo-Saharan descendants typically established seasonal patterns of herding, moving livestock between highland and lowland pastures to the east and west of the Nile, where native wild grasses were sustained in the desert steppe climate and in the hills.

Some time around 10,000 B.C.E., populations were moving farther north into the dry steppe regions, where Nilo-Saharans invented the production of food by cultivating wild grains and raising cattle for meat and even dairy products. It seems, from available evidence, that the grain cultivating and cattle raising innovations of Nilo-Saharan peoples emerged partially because the new ecosystem in the expanding grasslands provided an environment distinct from the more arid parts of the southeastern Sahara. The discovery of new ideas and techniques was furthered in the new ecological context. These first agriculturalists spoke a proto-Sudanic language of the Nilo-Saharan

language family. Before 10,000 B.C.E., the pre-agropastoral Nilo-Saharanans collected food by hunting small- to medium-sized mammals of the grassland steppe such as hares. The practice of hunting most likely continued as a supplement in conjunction with food production for several millennia.

The Nilo-Saharanans of the eleventh millennium and later centuries increasingly came into contact with Erythraian populations speaking Afrasan languages (also known as the Afro-Asiatic language family). Nilo-Saharan and Afrasan contacts between the Nile River and the Red Sea Hills extended over three millennia and resulted in a cultural exchange and interaction that produced a fertile tradition of grain cultivation. The Northern Sudanians adopted the practice of grain collecting from their Erythraian neighbors and went beyond collection to the domestication of the grains. Northern Sudanians also incorporated the grindstone into their own technological repertoire. Interestingly, the Northern Sudanians employed the grindstone in slightly different ways than their Erythraic neighbors had, in that they refined tropical African grasses such as fonio, pearl millet, and sorghum rather than the grains that their neighbors more typically utilized.

The Nilo-Saharanans began to produce so-called Wavy Line pottery in quantity from about 9000 B.C.E., and it is assumed that they had attained this skill even centuries before production became widespread. This pottery is identified by the wavy line motifs used in decorating the exterior of the pots. By 9000 B.C.E., their skill in pottery had achieved a relative sophistication, and between 8000 and 6000 B.C.E., the technique began to spread to Erythraite communities to the north and east of the Nilo-Saharanans. By 7000 B.C.E., Nilo-Saharan pottery skills had spread into Saharan Africa to the west as well. Thus there was an extended period of pottery dispersal out of the corridor between the Red Sea and the Nile into the regions to the north and northwest. Both Nilo-Saharan Northern Sudanians and the Afrasian Erythraites had drawn on ideas introduced by their regional neighbors and then made innovations to suit their own environmental needs and sociocultural preferences.

Through the archaeological evidence, agroecology, and geographic analysis, a history of interaction between Nilo-Saharan and Erythraic communities is evident. In the Nile-Sahara cross-zone, ancient cattle



A drought-resistant crop that requires only a short growing season, sorghum is an ideal grain crop in Africa's many semiarid regions. Archaeological evidence has shown that West Africans began experimenting with the crop more than nine thousand years ago. (PhotoDisc)

bones, potshards, and grain seeds are distributed in a manner that demonstrates to scholars that communities with distinct backgrounds came together in certain regions and shared ideas; from about 10,000 B.C.E., there was population movement that resulted in identifiable cross-cultural interaction between Nilo-Saharan and Erythraic communities in northeastern Africa. Food production began to emerge between 10,000 and 9000 B.C.E., and through Nilo-Saharan and Erythraic interactions, grain cultivation and cattle raising spread at the crossroads of the Nile and Sahara. Within the same broad time frame, pottery production emerged as an extension of the new economic lifestyle and new needs that arose within that way of life.

SIGNIFICANCE

Wavy Line pottery is the oldest known earthenware pottery of Africa, and in terms of global history it is second only to ceramics of Japan in antiquity. Pottery's significance lies in its usefulness for innovation in

cultural and everyday practices. In particular, pottery allowed for novelty and diversity of cuisine and food preparation. With pottery, people could prepare porridge, stews, soups, and sauces to be integrated as supplements into a diet of breads and roasted meats.

For settled populations, pottery also provided creative storage options not only for food, but also for fermented drinks of alcohol, medicinal brews, and herbal products. Pots could be heated to high temperatures, unlike wooden or leather holding vessels; other containers such as the vessels made from animal skins, gourds, and wood that preceded ceramic wares were less durable and less varied in size and shape than the earthenwares could be, and thus ceramics allowed more choice, diversity, and creativity.

A major significance of food production in cattle raising and grain cultivation is that it supported Nilo-Saharan population growth. As populations increasingly expanded in numbers, they often opened out into new territories, carrying the Wavy Line pottery as well as systems of food production into new regions. Population growth and expansion lead to even greater innovation and diversity in the language, culture, and lifestyle of northeastern and north central Africa.

The ancient Nilo-Saharans and their Erythraian neighbors developed lifestyles and economic systems that have served as the basis of economy and society for Sudanic and Cushitic peoples of northeastern Africa into modern times. Although there has been significant change over time, elements of the socioeconomic structures of northeastern Africa are a result of ancient Nilo-Saharan agropastoral innovators.

Catherine Cymone Fourshey

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■ **C. 8000 B.C.E.**

FIRST AGRICULTURAL SETTLEMENTS ARISE ON ANDEAN ALTIPLANO

Early peoples first established permanent settlements on the high Andean grasslands, gradually shifting from hunting and gathering to domesticating animals and plants and engaging in agriculture.

LOCALE: Central Andean high grasslands, Peru

AGRICULTURAL ISSUES: Archaeological discoveries; Climate change;
Hunting and gathering; Tropical produce

SUMMARY OF EVENT

The early part of the Archaic period (8000-2000 B.C.E.) is marked by rapid change in environment and therefore in human lifeways. For the most part, the early Archaic Andean peoples were generalists, hunting and collecting, using spears, atlatls, nooses, snares, and traps to secure animals and opportunistically collecting plants available in the local setting.

Work at Lauricocha and Guitarrero caves in northern Peru indicated that these early peoples had seasonal occupations, with groups dependent on hunting deer and wild camelids (guanacos and vicuñas) beginning in about 8000 B.C.E. In this area, researchers first noticed the virtual depopulation during the middle Archaic period, coinciding with the Hypsithermal climatic period (a warmer period that lasted from 6000 to 3500 B.C.E.), a pattern that is seen much more clearly farther south.

In central highland Peru, the sites of Pachamachay and Telarmachay were inhabited by groups of people ranging in size from fifteen to fifty members, with a norm of around twenty-five members, of relatively egalitarian status. Based on the large quantities of camelid bones found in the excavations at Pachamachay, the excavators argued for the existence of a hunting group with limited mobility by 6000 B.C.E., followed by a group of specialized, year-round, sedentary, full-time vicuña hunters from 4000 to 2000 B.C.E., with a later shift to herding of camelids and some farming of quinoa and tubers. How-

ever, reanalysis of the materials indicated a seasonal utilization, not a year-around sedentary camp.

The work at Telarmachay also produced prodigious numbers of camelid bones, but analysis indicated that the site was used only during the wet season from November to March. Telarmachay burials included a child covered with red ocher and wearing a necklace of shell beads and pendants and a woman buried with a hide-working kit, including needles, awls, knives, and scrapers. Based on these burials and evidence from other high Andean sites, archaeologists believe that, beginning during the early Archaic period, these peoples developed a ritual treatment of the dead in which the bodies were treated with red ocher, and individuals were buried with decorative items (pendants and necklaces) and productive items (sewing, hunting, and butchering tool kits).

The Telarmachay site provides the first good evidence for a shift from the mixed hunting of deer and wild camelids to a focus almost exclusively on wild camelids by 4000 B.C.E. and the first domestication of alpacas after 4000, with full-time pastoralism by 3500. Work with mitochondrial and microsatellite DNA (deoxyribonucleic acid) indicates a very high genetic similarity between alpacas and vicuñas and between llamas and guanacos. The llama and alpaca were probably not domesticated in the same region. Domestic llama remains from 2500 B.C.E. have been recovered from the south-central Andean region, and it appears that both llamas and alpacas were available to Andean herders by 3000-2500 B.C.E.

In the southern Peruvian zone, the sites at the Ayacucho caves and Asana provide additional patterns of settlement. During the early and middle Archaic period, Ayacucho caves were inhabited by larger bands that broke into smaller bands and dispersed during the dry season. Intensive utilization of guinea pigs began as early as 9000 B.C.E. in Ayacucho, with possible domestication of the animal by 3500. During the middle and late Archaic period, the cave inhabitants added llamas, alpacas, quinoa, squash, bottle gourds, chili peppers, amaranth, potatoes, beans, and cotton to the list of plants and animals that they used.

Asana was first used about 8000 B.C.E. by coastal groups as a temporary hide-working camp. After 7500, it was transformed into a base camp for a hunting group exploiting the high sierra and puna (ba-

C. 8000 B.C.E.



A distant relative of the camel, the South American llama was one of the few draft animals used in the pre-Columbian Americas and was also an important source of protein before Europeans introduced cattle, sheep, and other domesticated animals. (Clyde L. Rasmussen)

sin) resources. During this early Archaic period, the residents constructed small circular residential structures, which were covered with brush and hides. The economy was based primarily on hunting deer, wild camelids, and various small mammals and collecting various wild fruits and tubers. Nearby were short-term field camps (such as stone quarries, hunting blinds, butchery sites, and plant-gathering loci). The site function changed dramatically and abruptly at 3000 B.C.E., no longer serving as a base camp for hunter-gatherers but rather as the herding residence for a single extended family, with a corral. The economy of these herders exhibited more intensive plant usage, including a domestic chenopod (quinoa), algarroba (mesquite) pods, cactus fruits, wild seed plants, and wild tubers. Asana has provided a very dynamic record of evolution of patterns, from the early transitory exploitation of mountain resources by coastal populations beginning to colonize the sierra, to permanent establishment of high sierra base camps used for several millennia, to the shift toward puna agro-pastoralism.

Quelcatani in the Titicaca basin exhibits a slightly different pattern. In this area, from 4500 to 2000 B.C.E., the rainfall was much reduced, resulting in Lake Titicaca dropping in level 380 feet (100 meters) or more, becoming a highly saline, landlocked lake with no functioning outlet, and the basin itself having a comparable greatly reduced number of animals and plants available. Quelcatani, however, was situated on a small marsh. Hunters lived in small ovoid rock houses and used the site as a short-term residential base camp until 2000 B.C.E., when there was a shift to llama herding, guinea pig raising, and the beginnings of potato, oca, ullucu, tarwi, and quinoa agriculture over the new few centuries. Cave sites here are well known for a variety of rock art, including images of deer, camelids, felines, humans hunting and herding, and various geometric patterns—some of the art drawn by earlier hunters and some by later herders.

The dry and salt punas of the south-central Andes show evidence of the Middle Archaic period depopulation. In the north Chile altiplano, paleo-lakes disappeared shortly after 6000 B.C.E. As the area became progressively drier, populations either moved down to the coast or adopted more sedentary patterns of resource use by settling close to the few perennial water bodies. From 6000 to 2000 B.C.E., only a few sites, such as Purpica 1 and Tulan 52, occur near permanent water sources. Both of these were sedentary villages of twenty to forty circular stone houses. Domestication of camelids began in about 2500 B.C.E., and irrigated agriculture of quinoa, potato, beans, gourds, and chili peppers developed with the large-scale reoccupation of the sierra area linked with the lake level rising, perhaps as early as 2000 B.C.E.

SIGNIFICANCE

The settlement of the high Andean grasslands, beginning in about 8000 B.C.E., led to a significant increase in their usage by human populations. During the early half of the Archaic period, these populations followed two general patterns of settlement: a high grassland edge or high sierra pattern, in which groups hunted wild camelids and deer, supplemented their food sources by collecting, and moved with the seasons between the highlands and lowland, and a central puna and altiplano pattern, in which the populations were much more sedentary. During the Archaic period, these populations ex-

c. 8000 B.C.E.

panded their subsistence resources with the addition of domestic plants and animals, further enabling the settlements to become permanent and the land to become continuously populated. A period of warmer and drier climate led to a reduction in the use of the high grasslands but not their abandonment.

David L. Browman

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First Agricultural Settlements Arise on Andean Altiplano

SEE ALSO: c. 10th millennium B.C.E.-10th century C.E.: Agriculture and Animal Husbandry; c. 500-1000: Tiwanaku Culture Develops Cold-Weather Agriculture in Andes; After 850: Chan Chan Advances Andean Agricultural Technology; c. 1000: Failed Agriculture Spurs Huari and Tiwanaku Collapse; 1471-1493: Inca Empire Expands and Strengthens Its Economic System.

■ **C. 8000-C. 1000 B.C.E.**

EARLY NATIVE AMERICANS FORM AGRICULTURAL COMMUNITIES

North American Archaic Indian cultures adapted to changing environments, evolving from hunter-gatherer bands into organized communities that supplemented natural food sources with cultivation, developed artwork, and formed trade networks.

LOCALE: North America

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Climate change; Drought; Ecology and environment; Hunting and gathering; Native American agriculture; Subsistence agriculture

SUMMARY OF EVENT

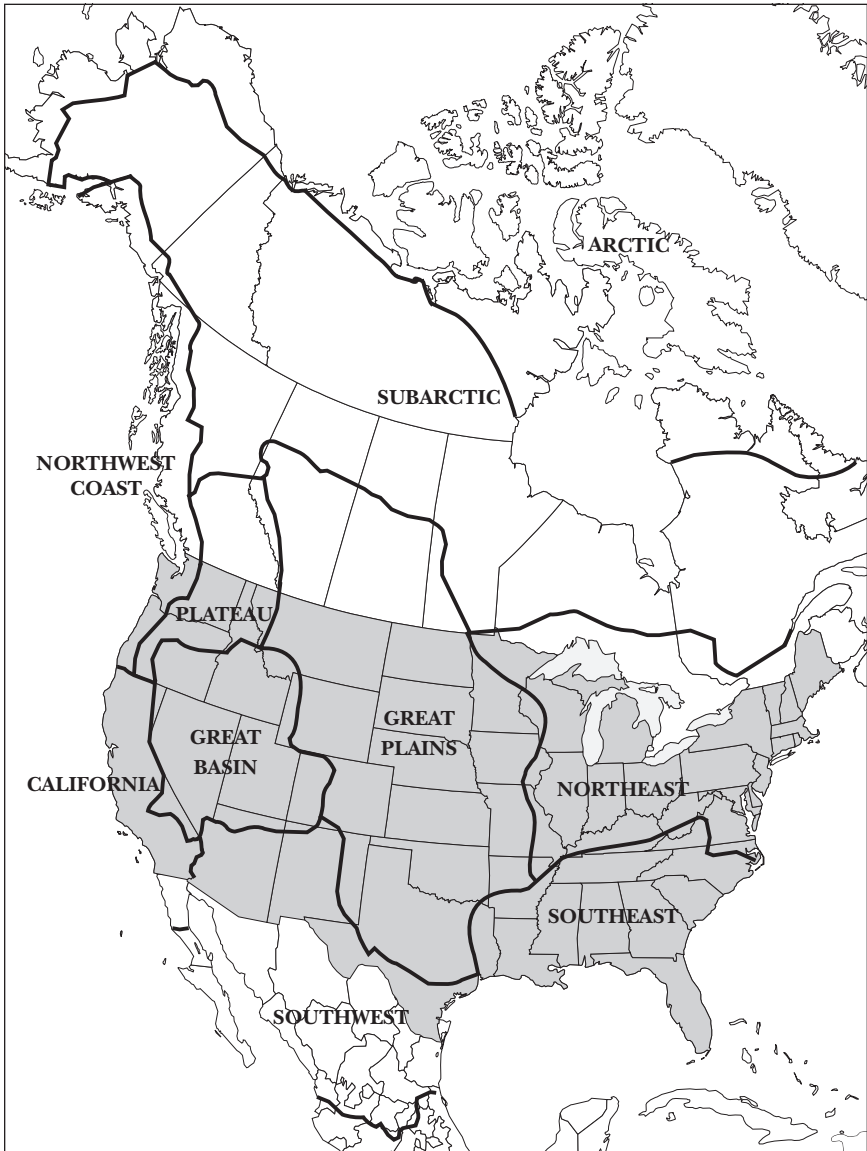
Archaeologists identify three major Archaic cultural areas and trace their evolution through the Early (8000-5500 B.C.E.), Middle (6000-3000 B.C.E.), and Late (3000-1000 B.C.E.) Archaic periods. The Western Indian culture extended from the Pacific Ocean east to the Rocky Mountains and south into Mexico. The Plains Indians ranged from the eastern Rockies to the Red River and lower Missouri River drainage area. The Eastern Woodland culture covered the United States from the Mississippi River eastward to the Atlantic Ocean. As climate changes brought environmental change, Archaic Indians adopted new technologies and lifestyles.

By 8000 B.C.E., the western United States and northern Mexico were undergoing searing heat and drought. Lakes evaporated, forests receded, grasslands withered, large game animals migrated to more favorable climates, and the Indians of the Southwest began their evolution into what archaeologists call the Desert Archaic period. Some archaeologists think that the Desert Archaic culture originated in northern Mexico, while others point to evidence of origins in southern California, Nevada, and western Arizona.

The Early Desert Archaic people traveled continuously in small bands in their seasonal searches for food and water. They may have

built brush or skin shelters at campsites, or lived in available caves and rock shelters. They spent spring and summer in the mountains, hunting deer and gathering berries, acorns, and pine nuts, then returned to lower elevations for the winter. The hunters used spears

CULTURE AREAS OF NORTH AMERICA



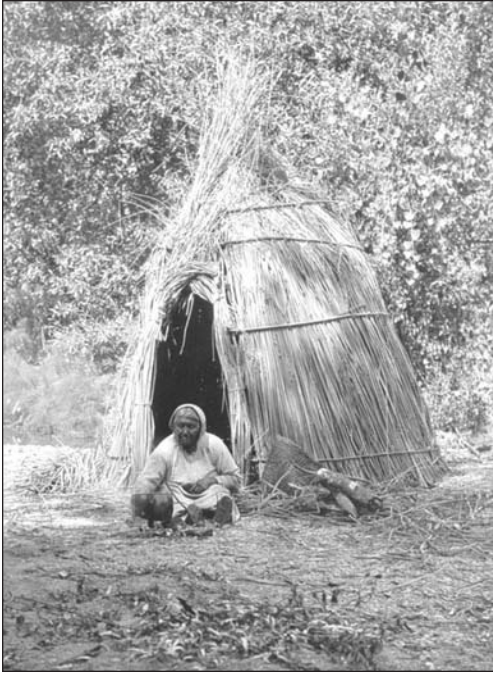
and fiber nets for hunting mule deer, mountain sheep, and rabbits. Women used sharp stones and chopping blades to chop agave and yucca stalks and stone bowls and mortars for pulverizing large seeds and cracking nuts.

The Middle Desert Archaic period saw an easing of the drought. As a result, the people settled into village life, growing maize, squash, and other crops in addition to hunting and gathering. Between 2500 and 1000 B.C.E., the Late Desert Archaic cultures established villages consisting of pit houses, fire hearths, and roasting pits grouped around a central plaza. They sent out hunting parties to bring back game, plants, and stone for tools. As the Late Desert Archaic people prospered, they opened trade routes to the Pacific coast and Mexico. Village workers dug wells to supplement water reserves. Craftspeople made bone and shell beads. Shaman artists painted and chiseled figures and symbols, probably of spiritual significance, on stone surfaces.

When the Late Desert Archaic people faced another period of drought (c. 1000 B.C.E.), they enlarged the permanent villages with more pit houses. They expanded their range of wild plant resources and agriculture, adding pumpkins, beans, amaranth, and more productive strains of corn. They created methods of preserving and storing food and maintained caches of materials for tool and trade goods. Desert Archaic people honored some but not all of their dead with grave goods, suggesting differences in social standing or material wealth.

Early Archaic sites of occupation in the Plains and Eastern Woodlands are identified by tools required in big-game hunting—chipped stone spear points and knives, atlatls (throwing spears), and bone needles for sewing animal skins. By 7000 B.C.E., the mammoths were gone and the Early Archaic people turned to forest mammals such as deer, bear, elk, fox, opossum, raccoon, squirrel, and rabbit, supplemented by nuts and plant foods. As the nomadic bands found plant and animal species in specific locations during particular seasons, the hunter-gatherers developed permanent camp sites and a regular pattern of moving to and from hunting and gathering grounds to coincide with the availability of resources at particular places.

There is little archaeological evidence of occupation in the Plains until about 2500 B.C.E. Campsites of big-game hunters dating from



Modern Pomo woman cooking acorns. (Library of Congress)

5000 B.C.E. indicate that the Plains people remained primarily hunter-gatherer bands for another two thousand years, although sites at Mummy Cave and Medicine Lodge Creek in northwestern Wyoming show evidence of prolonged seasonal residence. Cultural evidence includes tubular bone pipes, fragments of coiled basketry and vegetable-fiber netting, leather scraps, wood trimmings, and flint chips. Refuse indicates reliance on numerous types of small animals and fowl for meat until the Late Archaic period, when the bison population began to recover from the severe drought.

The efficient hunters and gatherers of the Eastern Woodland thrived throughout the Archaic period. Early Archaic hunters and gatherers occupied base camps along major waterways and utilized nearby food and tool resources. Middle Archaic Indians in the southeast developed permanent settlements and adapted technology to exploit the specialized plant and animal resources of a specific environment. Excavations at sites near rivers and lakes have produced numerous stone tools, including knives, choppers, scrapers, gouges, perforators, drills, and hammer stones, as well as corner, basal, and

C. 8000-C. 1000 B.C.E.

side-notched arrow and spear points. Recent findings at the Wind-over site near Titusville, Florida, include bone and barbed points, fishhooks, pins, shell adzes, cloth fragments, and wooden canoes, which indicate an established community relying on fishing and gathering for subsistence.

As southeastern forests increased, the people developed tools for building canoes, housing, and other wooden objects. Archaeological digs of base camp sites along rivers and streams have uncovered storage pits, parts of house floors, and prepared burials, confirming the transition to permanent villages. Radiocarbon samples in Louisiana have confirmed mound-building traditions in use by 3000 B.C.E.

The Late Archaic period (3000-1000 B.C.E.) in the eastern United States was marked by the transformation of economies from family and community subsistence to extended trade networks. Pottery technology flourished and dispersed through the trade networks. Excavations reveal regional specialization by ethnic cultures whose tools and practices reflect their adaptation to the changing environment. In New England, for instance, smooth, half-moon-shaped knives were used to exploit sea mammals and forest animals for furs, food,



Artist's depiction of Native Americans using traditional techniques to catch fish in late nineteenth century North Carolina. (National Archives)

and bone tools. The use of “sweet” acorns (with little tannic acid) marks the spread of Lamoka cultural patterns along the Susquehanna River and the Atlantic slope. South Atlantic coastal cultures settled in villages and utilized saltwater oyster beds as resources. In the Northeast, the forest culture is sometimes called the Shield Archaic, for the distribution of this Algonquian-speaking culture conforms to the spread of the Canadian Shield, a horseshoe-shaped geographic area covering eastern and central Canada and a small part of the northern United States. The Shield Archaic people were direct ancestors of the Algonquian tribes of the historic period.

Cultural differences were reflected in burial traditions. Unlike the pit burials found in Maine, in Newfoundland, and on the Quebec-Labrador border, the Eastern Woodland culture established villages with cemetery mounds of stone or logs covered with earth. During the late Archaic Midwest, the dead were either cremated or interred in flexed or extended positions.

Shell ring sites along the coasts of South Carolina, Georgia, and northern Florida, as well as the great earthen mounds of the Mississippi culture, appeared during the Late Archaic period. Kenneth Sassaman examined deposits at the Stallings Island site on the Savannah River upstream from Augusta, Georgia, and found evidence of intensive occupation for about two centuries beginning in 3000 B.C.E. Recent excavations at Mims Point in South Carolina uncovered houses of a Stallings culture community (c. 1600 B.C.E.) that were arranged in ringlike fashion around a communal plaza. A shell ring in Beaufort County contained pottery identical to the Stallings fiber-tempered pottery. Archaeologists speculate that the larger shell ring sites, like the massive earthworks at Poverty Point in Louisiana, served as regional centers for cultural ceremonies, games, and trade.

SIGNIFICANCE

The Late Archaic period (1000 B.C.E.), marked the evolution of hunter-gatherer bands into organized sedentary communities, where subsistence depended upon agriculture and horticulture in addition to hunting and gathering. The appearance of fiber-tempered pottery in the southeastern United States and its spread northward and westward was a cultural advance that enhanced the development of widespread trade. The Desert Archaic culture spread throughout Ari-

C. 8000-C. 1000 B.C.E.

zona, New Mexico, western Texas, southern Utah, Colorado, northern Sonora, and Chihuahua, foreshadowing the rise of the Pueblos of the Southwest. The Eastern Archaic Indians initiated the mound-building traditions of the successive Woodland and Mississippi cultures.

Marguerite R. Plummer

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■ C. 7500 B.C.E.

EAST ASIANS BEGIN CULTIVATING GRAIN

The beginnings of grain cultivation in East Asia have been traced back to Neolithic village sites in the middle and lower Yangtze River regions.

LOCALE: Present-day Hunan and Hubei Provinces, China

AGRICULTURAL ISSUES: Archaeological discoveries; Climate change; Flooding

SUMMARY OF EVENT

Although China's history is ancient and well documented, the origins of agriculture in this Asian cradle of civilization predate its written history by thousands of years. There are five "sacred foods" in Chinese lore: rice, millet, nuts, soybeans, and barley, all of which have been cultivated since prehistory. It is likely that their elevated status is due to both their nutritional value and the ease of long-term storage. Of these foods, domesticated rice has had the most wide-ranging effects throughout the world.

Rice chaff and husks have been found in pottery containers at Pengtoushan in the central Yangtze Valley, dated from between 9000



*Chinese farmer
sitting by his rice field.*
(Library of Congress)

and 7800 B.C.E. No agricultural tools were discovered among the artifacts, and it is unclear whether this the rice was wild or cultivated. Many Asian archaeologists believe the latter is the case, based on study of plant remains from more than a hundred such early sites.

Bashidang, a site that has been carbon-dated to approximately 7540-7100 B.C.E., holds voluminous proof of rice cultivation. Like Pengtoushan, it is on the Dongting Lake plain in the middle Yangtze region. Bashidang is a stratified site with layers of rice paddies, dwellings, burials, polished stone tools, and many plant and animal remains. Its material culture traits seem directly descended from those found at Pengtoushan.

Hemudu, a lakeside village near the coast in the river's lower reaches, provides a glimpse into the spread of rice culture and the material changes that had accompanied it by 5000 B.C.E. Besides the grains, stalks, and leaves of rice, there are other food remains such as sour dates and many varieties of fish. Hemudu also had tools for digging and spreading.

Geography and climate combined to create conditions for the agricultural revolution in China. Periods of cold, dry weather alternated with warmer periods, which allowed wild grains to spread profusely. The Yangtze basin had many lakes as well as seasonal flooding, which provided both rich soil and the periodically flooded fields that are optimal for rice's growth cycle.

Most of the archaeological studies on these and other sites of early Chinese grain growing have taken place since the 1970's. Although new findings could lead to new theories, it appears that grain cultivation in the Yangtze basin predates that of other areas in Asia. It may even predate the earliest known traces of barley cultivation elsewhere, which date back to 8000 B.C.E. and were found at the Netiv Hagdud site in present-day Israel. There is no evidence of contact between very early farmers in the Middle East and in China. Agriculture seems to have been invented independently in the two areas.

Along with rice, millet was also cultivated, as well as being grown in the Yellow River region of northern China. Millet, the grain of a number of different grasses, is hardier and thrives in a colder climate than rice, so it was a natural crop for the more northerly region to adopt. Ongoing contact between the two regions in prehistoric times is more than likely. Millet is relatively neglected during the twenty-first

C. 7500 B.C.E.

century as a human food source, but its protein and vitamin content is high. Flatcakes, wine, and gruel made from millet have long been consumed in China.

Chinese mythology recognizes the importance of grain growing in several myths regarding its origin. Shen Nong (Shen Nung) is said to have been the first farmer, an agricultural god who invented the digging stick and the spade. His son Zhu is given credit for first growing millet. Another tradition tells of Zhou Qi (Chou Ch'i), who discovered how to grow edible plants as an abandoned child and in adulthood was made the official in charge of agriculture. Both versions ascribe the invention of agriculture to the need to feed a growing population. Whether or not this is historically true, the influence of population pressures is a persistent theme in Chinese history.

SIGNIFICANCE

Rice and millet cultivation spread from China to the rest of Asia. Japan and Korea, Taiwan, the Southeast Asian countries, and India all built cultures with an agricultural base of rice cultivation. Grain cultivation is closely linked with solidification of permanent settlements and the domestication of animals. In China as in other places, the dog was the only animal to be domesticated before the agricultural revolution. The settled life and increased food supply of an agricultural lifestyle led, in China, to the early domestication of pigs and chickens, as well as oxen, goats, sheep, and cats. Throughout the world, the agricultural revolution marked a major change in the way that society was structured and functioned; in China, the revolution was centered on rice.

Emily Alward

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■ **c. 6500-C. 5000 B.C.E.**

NILO-SAHARAN FARMERS SPREAD CULTIVATION AND HERDING

Nilo-Saharan speakers spread the practices of cultivation and herding westward across the Sahara and the Sudan Belt into the Eastern Sahara and also eastward across the upper Nile plains; these practices led to the establishment of farmsteads and the production of cotton textiles and leather products.

LOCALE: Sahara and Sudan belt (across modern-day Sudan, Egypt, Chad, and Niger)

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Cattle keeping; Innovations; Population growth; Subsistence agriculture; Textile industries; Tropical produce

SUMMARY OF EVENT

One of the most remarkable early events in the history of Africa is the shift from food consumption by way of collection to food production in farming and herding. In the long view, agricultural production and animal husbandry created new opportunities and resources that had a major impact on all aspects of society, economy, and politics throughout the continent.

One of the independent inventions of agriculture linked to animal husbandry took place between 6500 and 5000 B.C.E. among Nilo-Saharan people. The Nilo-Saharan language family includes groups as diverse as the Kanuri of the Kanem-Bornu region in the central Sahel and the Luo and Maasai of eastern Africa. Before true cultivation, Nilo-Saharan speakers collected wild grains and in time added wild grass (sorghum, fonio, pearl millet) to their repertoire. Along with grain collection came important technologies such as grindstones and pottery, which the archaeological record reveals preceded the development of agriculture by as much as two millennia. Although still collectors of grasses and grains, the Nilo-Saharan communities had the apparatus necessary to stew porridge and sauces. In particular, it was the Northern Sudanic branch of the Nilo-Saharan



West African cattle.
(©Nael_Pictures/
Dreamstime.com)

culture that collected grains and produced pottery by the tenth millennium B.C.E.

Archaeology indicates that by 8000 B.C.E., the Northern Sudanic communities had begun to domesticate wild cattle, an event that may mark the first production of food in all of Africa. The deliberate act of nurturing and looking after animals that would be used for human consumption had such an important impact on the control people had in sustaining their communities nutritionally that animal domestication itself constituted a revolution. Cattle keeping in fact had major demographic consequences, as it must have been at least partially responsible for greater population growth and density. Culturally, reliance on domestic cattle as a food resource reshaped how people thought about the land; they no longer looked at the use of land for food collection but rather as a place to graze cattle. Archaeological and linguistic evidence indicates that in the eighth and ninth millennia B.C.E., northern Sudanians practiced seasonally migratory cattle raising to maximize use of Sahelian grazing lands and to avoid depleting them.

One branch of descendants of the Northern Sudanians, the Saharo-Sahelians, began plant domestication in this region between 8000 and 7000 B.C.E. Much as their northern Sudanian ancestors had done before them with cattle, the Saharo-Sahelians began to inten-

C. 6500-C. 5000 B.C.E.

tionally sow grain seeds and nurture the plants. The combination of grain cultivation and cattle raising once again enhanced the yield of food production, which provided resources to sustain growing populations. The intensification of food production would have preceded substantial population growth. This tradition of cultivation began as a grain-seed tradition, but between 7000 and 5000 B.C.E., these cultivators incorporated gourds, calabashes, watermelons, and even non-food crops such as cotton into their agricultural system. These burgeoning farmers, speaking languages of the Nilo-Saharan language family, spread cultivation and herding westward across the Sahara and the Sudan Belt, into the eastern Sahara and also eastward across the upper Nile River plains. Particularly during the later sixth millennium B.C.E., these Sudanic farmers spread as far west as the bend of the Niger River.

SIGNIFICANCE

The invention of food production through agriculture revolutionized societies at all levels. Agropastoralism fundamentally changed the way ancient people related to their environments, how they used time, and how they organized communities politically, socially, and economically.

Although cattle raising required transhumance (seasonal movement of livestock by herders), grain cultivation necessitated longer-term settlement in order to care for farm plots. The settlements of the Saharo-Sahelians can be characterized as farmsteads that were communities enclosed by thorn-bush fences to safeguard cattle, granaries, and households from predatory animals and wild vermin. The residential structures were adaptations of earlier temporary settlements. These tended to be dwellings for extended families, built on a circular floor plan, that were topped off with conical thatched roofs.

The farmstead was divided into spaces for living, cattle pens, granaries, and probably public activity. The cultivation of grain crops thus led to new social organization, new architectural styles, and the development of granaries for storage. Additionally, the Saharo-Sahelians who were cultivating more regularly began to bore water holes and wells in or near the farmstead to make water available for both human and animal needs. Cattle feeding still necessitated sea-

sonal grazing, but the presence of well water and food stores alleviated the need for frequent movement of the entire population. These agropastoralists were increasingly seeking out permanent local resources for subsistence. What is striking about the Sudanic homestead is that the house building style shows a pattern of uniformity from the Niger Bend in the west to the Middle Nile Basin in the east.

Beyond the realm of subsistence, the development of agropastoral food production contributed also to the growth of material products such as cotton textiles and leather products. As Saharo-Sahelians experimented with cultivation of grain seeds, they also domesticated cotton. The domestication of cotton was followed by the important development of the spindle whorls made of baked clay. As early as 5000 B.C.E. cotton was being spun and woven; this is demonstrated in the Middle Nile Basin inhabited by Saharo-Sahelians by the presence of the spindle whorls used to twist and coil cotton thread. This technology spread farther west, where cotton weaving became an important domain of cultural and artistic production.

Parallel to cotton textiles emerging from agriculture, the production of leather goods emerged as a result of cattle domestication. The presence of domesticated cattle in significant numbers, particularly for human consumption, contributed to the availability of raw leather and horns for production of material objects. Horns were used for musical instruments such as trumpets for either entertainment or sounding news. The availability of new kinds of excess raw materials such as cotton, horns, and leather provided the materials that creative persons used to establish professional occupations.

Thus the important developments of food production in agriculture and cattle raising also produced cultural innovations. The Nilo-Saharan, Northern Sudanian, and Saharo-Sahelian legacies of agropastoral invention and elaboration served as the foundations for the important technological and creative arts, which were widely separated temporally and geographically, spreading from ancient Egypt to Kanem-Bornu.

Catherine Cymone Fourshey

C. 6500-C. 5000 B.C.E.

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■ **C. 6200-C. 3800 B.C.E.**

UBAID CULTURE BEGINS MESOPOTAMIAN AGRICULTURAL COMMUNITIES

The Ubaid period, transitional between Neolithic farming cultures and early civilization, witnessed a series of economic and ideological changes that culminated in urbanism and more complex forms of social organization, all of which were built on improved agricultural production.

LOCALE: Greater Mesopotamia (now Iraq and parts of Syria, Iran, and Turkey)

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Draft animals

SUMMARY OF EVENT

The term Ubaid refers to an archaeological site, a distinctive ceramic type, and a long cultural period. The site, Tell al-Ubaid, is located about four miles (six kilometers) west of Ur (now Muqaiyir) along the Euphrates River in Iraq. The site was explored by the British Museum in 1919 under Harry R. Hall and during 1923-1924 by Sir Leonard Woolley. Woolley applied the term Ubaid to designate the prehistoric sequence associated with painted ceramics. In 1960, the ceramic sequence for the Ubaid period was constructed by Joan Oates, and ultimately five phases (Ubaid 0-Ubaid 4) have been recognized.

The wares of Ubaid potters enjoyed a wide distribution: They have been found from central Turkey to the highlands of Iran and southward to the Persian Gulf region. Pottery was painted and unpainted as well as impressed and incised. Examples included beakers, bowls, and jars of different sizes and shapes. Ubaid ceramics enjoyed a remarkable homogeneity in terms of style, shape, and decorative motif, while being locally manufactured. Painted Ubaid ware was fired at high temperatures and constructed of a green, red, or buff paste, with brown or black geometric designs.

As a cultural period, Ubaid marks the earliest appearance of sed-

entary agricultural communities on the southern Mesopotamian alluvial plain. Settlements, both on the southern alluvial plain and in northern Mesopotamia, were small. On the Diyala Plain in Iraq, villages approximating fifty to one hundred individuals were located about six to twelve miles (ten to twenty kilometers) apart. However, in the southern region, the rich soil and improved agricultural techniques, such as irrigation, permitted a surplus that fostered population growth. By the terminus of the Ubaid culture, the urban center of Eridu in southern Mesopotamia (site now south of An Nāsirīyah, Iraq) contained between two thousand and four thousand people.

The earliest Ubaid sites from northern Mesopotamia are quite small: Arpachiyah, east of Nineveh (near Mosul, Iraq), covered an area of about 1.5 acres (slightly over 0.5 hectare) and may have contained only one or two dwellings. Settlements seldom approached two acres (about one hectare) in size. Small population densities suggest that the northern Ubaid communities had an egalitarian, highly autonomous character. The absence of elaborate grave offerings in the Ubaid mortuary complex and the small community size suggest that complex social ranking and developed social differentiation were lacking. Any form of political hierarchy would appear to be weakly expressed, particularly during the sixth and fifth millennia B.C.E.

Archaeologists, however, have called attention to a shift that was under way by the mid-fourth millennium B.C.E., in which a structural change evolved whereby community-oriented interests and concerns were replaced with an ideological orientation on the individual level. This social change, evident in domestic architecture, early temples, and grave offerings, gradually replaced an egalitarian ideology with one rooted in social inequalities. This is particularly evident in southern Mesopotamia, where the need for centralized coordination of labor projects such as irrigation works and construction of sacred architecture gradually spread into other areas of society and culture. In northern Mesopotamia, however, the prerequisites for economic life were more variable and less dependent on collective labor.

Modern archaeological work has suggested that the Ubaid is not a single cultural entity, but rather a composite, consisting of widespread local variability. The general cultural style has been preserved in Ubaid artifacts, such as pottery and food-processing equipment, and in architecture, both domestic and sacred.

Mud brick was the basic construction material for Ubaid village architecture. Domestic units were small, with equally diminutive rooms that may have been used for storage of food, fuel, or animal fodder. Buildings were constructed on a tripartite plan that consisted of a rectangular room extending the length of the house, with smaller rooms placed along each side. The central room was secluded from the outside through the addition of flanking rooms. Floors were often coated with a gypsum plaster.

The Ubaid period witnessed the first appearance of sacred public architecture in Mesopotamia. The rectangular temples were of mud-brick construction and contained altars and other features, such as niches, which facilitated ceremonial activity. Temples appear early in the archaeological sequence (Ubaid I, about 5500 B.C.E.) and gradually become larger.

Agriculture was diversified: Several types of wheat, barley, beans, linseed, peas, lentils, the date palm, and vegetable crops were grown. Irrigation was a necessity in southern Mesopotamia. Sheep and goats were kept, in addition to cattle. The ox-drawn plow may have been in use by the fifth millennium B.C.E. The site of Tell Abada excavated during the 1970's by the Iraqi archaeologist Sabah Abboud Jasim pro-



Date palms, which remain important food crops in the Middle East. (Digital Stock)

vided evidence that hunting (of gazelle, deer, and boar, among other wild fauna) remained important. At Tell Abada, a water-distribution system was discovered in which ceramic pipes channeled river water and water trapped in large wadis (streambeds, usually wet only during the rainy season) into the village, presumably for human use.

Craft specialization and a variety of industries flourished during the Ubaid. Pottery kilns, ranging from simple to complex in construction, have been excavated at numerous Ubaid sites. Ceramic vessels, figurines, and other ceramic artifacts reveal a high degree of ceramic specialization. The output of Ubaid ceramic production was significant. Ubaid pottery was not made on a potter's wheel but on a tournette, in which the potter's table rotated on a peg. The true potter's wheel emerged toward the end of the Ubaid sequence. In addition to ceramic workshops, the stone-tool industry produced hoes, axes, sickles, scrapers, pestles, and grinding tools for processing cereals. Weaving and basket manufacture were also important industries in Ubaid villages.

SIGNIFICANCE

The Ubaid period is positioned at the terminus of prehistory. Although certain features of civilization are lacking, such as warfare and a developed social stratification system, the Ubaid period ushered in a number of prominent civilizational processes.

Ubaid settlements reveal the gradual formalization of religion. Large, nonresidential buildings of mud brick, most likely temples, were erected on platforms of clay or imported stone. Stairs led to the top of these structures, and they may anticipate the great ziggurats of Sumer. A platform at Susa (ruins at Shūsh, Iran) that may have provided the base for a temple was 11 yards (10 meters) high, about 88 yards (80 meters) long, and 71 yards (65 meters) wide.

The gradual movement toward occupational specialization during the fifth millennium B.C.E. suggests that the family as a productive and property-controlling unit was being replaced by more formalized social institutions. The older kinship-oriented society was ultimately eclipsed by formalized managerial institutions such as the temple, which in post-Ubaid times was a powerful economic, coercive, and spiritual force.

Regional trade was active during the Ubaid period. Items that

were essential to the productive economy of the village but were absent from local environments were sought after. Obsidian, limestone, natural asphalt, carnelian, and marine products from the Gulf region provide examples of desirable materials.

The precise form of leadership during the Ubaid period remains unknown. No archaeological evidence has been found attesting to great differences in political power, wealth, or prestige. By the latter stages of the Ubaid, a religious authority or a chief possibly controlled agricultural resources and coordinated labor projects. These functions may have been previously addressed through a council of village elders or a kin-oriented structure, for example, a lineage.

Small clay tokens, modeled into different shapes and found in Ubaid sites, may anticipate either a formalized record-keeping system or perhaps written accounts of business transactions. At Tell Abada, a clay proto-tablet was discovered, on which were inscribed numerous signs arranged in four lines. Jasim suggests these inscriptions may stand for numerical values and may anticipate writing for administrative and economic activity.

The Ubaid is a long and crucial archaeological sequence in which the prerequisites for an urban-based, state-level society were slowly becoming institutionalized.

Rene M. Descartes

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■ C. 6000-C. 1500 B.C.E.

YANGSHAO AND LONGSHAN BEGIN CHINESE AGRICULTURAL CULTURES

Yangshao and Longshan were the first known farming cultures in what is now northern China. During their existence, settled agriculture developed, then villages and towns were formed.

LOCALE: Yangshao, Henan Province, and Longshan, Shandong Province, China

AGRICULTURAL ISSUES: Archaeological discoveries; Diet, nutrition, and cuisine; Draft animals; Hunting and gathering

SUMMARY OF EVENT

Modern humans, *Homo sapiens*, arrived in the Yellow River (Huang He) Valley no later than 50,000 B.C.E. and survived by hunting and gathering. Early agriculture in northern China began perhaps as early as 8000 B.C.E., probably as slash-and-burn gardens in the uplands of the Yellow River Valley. Solid evidence of agriculture from Neolithic sites in northern China dates to about 5500 B.C.E. Because agriculture and bronze technology had probably existed earlier in Southeast Asia, the appearance of agriculture in the Yellow River Valley most likely resulted from the diffusion of culture from Southeast Asia through southern and central China. However, millet, the staple of early agriculture in northern China, is most likely native to the area and was probably domesticated locally.

The first fully Neolithic culture identified in what is now China was first recognized in 1921 at Yangshao (Yang-shao), in Henan (Honan) Province, from where the culture takes its name. Since the initial identification of Yangshao culture, hundreds of sites have been discovered in northern China. Yangshao culture, also called the Painted Pottery culture, was once thought to be directly ancestral to Chinese culture but is now seen as one of several Neolithic cultures that gave rise to Chinese culture. Yangshao was a step in the development of culture from total dependence on hunting and gathering to dependence on settled agriculture. Yangshao culture flour-

ished in northern China from approximately 6000 to about 1500 B.C.E., when urban civilization began to replace it and other Neolithic cultures.

Yangshao culture developed in the semiarid environment of northern China along the loess regions of the highlands of the Yellow River Valley. The presence of the loess, a fertile windblown sand that holds moisture well, allowed the development of widespread agriculture in this semiarid climate. Yangshao sites have been found along terraces on riverbanks. Yangshao settlements were usually situated in lands above the floodplain but near enough to a river to provide a stable water source. One of the most valuable of the Yangshao sites was found at Banpo (Panp'o), near the present city of Xi'an (Hsien) in the province of Shaanxi. The site, dated at around 4000 B.C.E., consists of a small village covering roughly 2.5 acres (one hectare). The village contained forty-five houses, with some two hundred storage pits scattered throughout the site. People from Yangshao culture villages grew millet, the main item in their diet, and raised domestic pigs, along with sheep and goats. They supplemented their diet with hunting and fishing. The Banpo site also indicated special burial grounds for the dead, with one area containing the graves of 174 adults and 76 children. Another thirty-seven funerary urns were also present at the site. Despite their relatively more sophisticated culture over earlier hunter-gatherers, Yangshao people still depended on tools made of stone, wood, and bone. They remained ignorant of metal until around 2000 B.C.E., when bronze technology arrived from the south.

Yangshao culture is identified by its style of pottery. Yangshao pottery was made without the benefit of a potter's wheel. Instead, strips of red or gray clay were pressed into shape. Red clay pottery was decorated with symmetrical abstract designs in red or black and occasionally with fish and human faces. Yangshao people hardened their pottery in kilns. Evidence of Yangshao culture has been found along a vast belt in northern China, roughly following the course of the Yellow River and its tributaries. In the east, Yangshao culture later overlapped with another Neolithic culture called Longshan.

Longshan culture, the next major identifiable Neolithic culture in China, was discovered in 1928 at Longshan (Lung-shan), in Shandong (Shantung) Province. Longshan culture probably arose about



Slash-and-burn agriculture, such as that practiced by the early Chinese, takes its name from the practice of clearing land for planting by cutting down trees and brush and burning them so their ashes will fertilize the soil.

one thousand years after Yangshao first appeared, around 4000 B.C.E., and existed at least through 2000 B.C.E. Longshan culture, also known as Black Pottery culture, represented a transition from slash-and-burn farming in the hills to settled agriculture on the floodplains. The exact relationship between Yangshao and Longshan cultures remains uncertain, with a basic disagreement over whether Longshan represents a later development of Yangshao or a culture that developed separately.

Village sites from Longshan culture are usually surrounded by walls made from stamped earth. Artifacts include fine pottery made with the use of wheels. At Longshan sites, researchers have identified high-temperature kilns in which Longshan people produced their gray pottery. Although Longshan people did not paint their pottery, they did decorate it with raised or grooved rings. Like the Yangshao people, Longshan people raised millet and pigs. However, evidence supports that they had domestic oxen and dogs. Also found at Longshan sites are heat-cracked animal bones, showing the widespread practice of scapulimancy, the interpretation of cracks caused

by rapid heating and cooling of animal bones. This practice evolved to scratching symbols on the bones, which became the basis for a pictographic and later ideographic writing system, which evolved into the Chinese writing system in use during the twenty-first century. Late Longshan people had learned to make silk, which would remain an exclusively Chinese skill for millennia. Evidence of early metal technology also exists, but its links to the later bronze technology found at a site in central Henan are uncertain.

Archaeological evidence uncovered near modern Zhengzhou (Chengchou) in 1957 dates from 1900 to 1600 B.C.E. The site, surrounded by earthen walls twenty feet (six meters) high and one mile (1.6 kilometers) square, might be the capital city of Yangcheng in traditional histories. One large complex, interpreted as a palace, was estimated to have taken 100,000 worker-days to build. Outside the walls were two foundries for casting bronze, indicating relatively advanced metallurgical skills. Traditional Chinese histories referred to the existence of a dynasty predating the Shang (1600-1066 B.C.E.), although no physical evidence existed until the discoveries near Zhengzhou. According to legend, the Xia (Hsia; c. 2100-1600 B.C.E.) Dynasty was founded by the legendary Yu (Yü), who personified the ideal public servant. Yu was the last of five mythical pre-Xia emperors. The five were credited with the development of fire, agriculture, animal domestication, writing, calendars, and flood control. These developments actually took place over many centuries but had all been achieved by the end of the Longshan period.

The Xia might simply be the late Longshan period, when various cultures merged. Although the existence of the Xia Dynasty has never been firmly proved, the site near Zhengzhou does show the existence of centralized control in parts of the Yellow River Valley during the late Longshan period, before the rise of the Shang Dynasty, and identifiable city-based civilization. That later Chinese historians wrote of a dynasty existing before the Shang indicates some continuity of culture from prehistoric to historic times in China.

SIGNIFICANCE

Although other Neolithic cultures contributed to the origins of Chinese culture, Yangshao and Longshan cultures represent a linear development of human society in northern China from earlier hunting

and gathering to fully settled agricultural societies. Longshan peoples developed many of the cornerstones of later Chinese civilization, including writing, veneration of ancestors, a tendency to build walls around towns, and the raising of animals such as pigs, which did not require pasturage or forage. Longshan later evolved into civilization in the Yellow River Valley, and late Longshan towns might be the basis for the perhaps mythological Xia Dynasty.

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■ C. 6000-C. 1000 B.C.E.

OMOTIC PEOPLES ADVANCE FARMING TECHNIQUES IN AFRICA'S HORN

Omotic peoples cultivated the ensete plant and yams and later interacted with Cushitic cattle and grain farmers to create an elaborate agricultural system that used irrigation, plowing, fertilizing, and stone-terraced mountain-sides.

LOCALE: Horn of Africa (Ethiopia)

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Climate change; Fertilizers; Innovations; Irrigation and water management; Subsistence agriculture

SUMMARY OF EVENT

Omotic populations descend from ancient southern Afrasans of northeast Africa who inhabited the southwestern region of what is now known as Ethiopia. Omotic culture began to emerge as a distinct ethnic group around 6500 B.C.E. The proto-Omotic peoples were at the forefront of a major cultural development in southern Ethiopia's highlands, where they pioneered the cultivation of the ensete plant, a relative of the banana, and Ethiopian yams. By the early third millennium B.C.E., Omotic populations had initiated another set of agricultural innovations in collaboration with their Cushitic and Nilo-Saharan neighbors. Cross-cultural interactions in the southern regions of the Ethiopian highlands on the Rift Valley borders resulted in the spreading across Ethiopia's highlands of irrigation and plowing, which came into practice by 2500 B.C.E.

Historically, the Ethiopian highlands were well positioned for agricultural invention and innovation. Surrounded by the Afrasan and Nilo-Saharan populations as well as the peoples of the Mediterranean and the Arabian Peninsula, the populations of the Ethiopian highlands have been able to draw from a variety of traditions in conceiving and crafting new forms of subsistence production. This central part of the Horn of Africa has provided an unusual environment for populations, which have had to endure the climate changes that

have occurred over the millennia. As climate and rainfall patterns have shifted and affected economic choices throughout the Horn of Africa, the people of the Ethiopian highlands also faced challenges but were able to maintain a varied agricultural system because of the region's high altitude, which ranges from 3,300 to 13,100 feet (1,000 to 4,000 meters), and environmental diversity.

The southern Afrasan, proto-Omotic populations first began to use uncultivated ensete (*Ensete ventricosum*) and to protect the plant in its natural habitat around 6000 B.C.E. True cultivation of ensete emerged among proto-Omotic populations between 6000 and 5000 B.C.E. because of climatic changes and increased rainfall that turned grasslands into forest in the Ethiopian highlands. Because the grains and sedges that Afrasan populations had collected for consumption became less plentiful as rainfall increased, the proto-Omotic people of the southern highlands increasingly shifted to tending the wild and abundant ensete by clearing land and cutting back forest to shelter the plant. Ensete, which thrives in high-rainfall regions, resembles the banana plant, with a fleshy stalk containing soft, pulpy tissue, but is fruitless. The pulp of the ensete trunk was dried, pounded, and used to make flour for porridge. This starchy staple was eaten with stews, vegetables, and sauces.

The Omotic populations of the sixth millennium B.C.E. inhabited the highlands bordered by Cushitic-speaking agropastoralists in the lowlands on the east, northeast, and southeast. In the west, Omotic communities shared borders with Sudanic pastoralists, particularly the East Sahelians and Nilotes of the lowlands. Between 5500 and 3500 B.C.E., Cushitic populations absorbed large segments of the Omotic population as they settled on Omotic land. The synthesis between Omotic ensete cultivation and the Cushitic farming practices of grain cultivation and livestock domestication (cattle, sheep, and goats) enhanced the economic options of lowland and highland populations.

Omotic peoples spoke languages of the Afrasan language family (also referred to as the Afroasiatic family), but lived in close proximity to Saharo-Sahelians, speakers of languages from the Nilo-Saharan language family. In this multicultural and multilingual context, there was a mixing of agricultural traditions as Nilo-Saharan farmers domesticated gourds, watermelons, and castor beans, which spread

northward to Egypt and east into the Rift Valley region by 3500 B.C.E. Gourds and beans added nutritional complexity to the diet.

Between 3500 and 1000 B.C.E., Cushitic populations were involved in a series of expansions into lands inhabited by Omotics. The Agaw Cushites became established in the north and north-central highlands at some point during this period. The Agaw carried finger millet, t'eff, wheat, and barley cultivation into the southern frontier of their settlements and absorbed the existing Omotic populations. The Agaw who moved into the northern highlands dominated because grain was better suited to cultivation in the northern highlands than ensete after the climate shifted back to being arid around 2000 B.C.E.

In the far south, the Eastern Cushites moved into the eastern highlands following the path of the dry Rift Valley lands and raising livestock such as cattle and goats. The Eastern Cushites also cultivated finger millet while the Omotic populations in the bordering highlands continued to grow ensete. The Highlands Eastern Cushites emerged as a subculture of Eastern Cushites by the second millennium B.C.E. They moved into the western edges of the rift onto Omotic lands, which created more of a cultural synthesis than did the Agaw movements. The major crop in the regions settled by the Highlands Eastern Cushites continued to be ensete, and finger millet served as an important secondary staple. Not later than the second millennium B.C.E., the Highlands Eastern Cushites developed an irrigation system on the slopes of the Rift Valley that employed natural streams and gravity to create furrows to move water to cultivated lands. The creation of this system corresponds to the drying out of the climate around 2000 B.C.E. The synthesis of Omotic and Highlands Eastern Cushites peoples resulted in some communities speaking Ometo and others speaking Highlands Eastern Cushitic, but all cultivated the two primary staple crops and raised cattle. Although the cultures divided linguistically, their cultures and economies blended. The Ometo speakers were in many areas absorbed by Cushites but not completely, as after 500 B.C.E., there was a resurgence and spread of Omotic populations and culture.

SIGNIFICANCE

Life in northeastern Africa before 6000 B.C.E. was predominantly dependent on food collection. This lifestyle of searching for and gath-

ering wild game and foodstuffs became increasingly sedentary and agrarian in nature between 6000 and 4000 B.C.E. The invention of ensete agriculture among the southernmost Afrasans located in the Ethiopian highlands was one of three independent inventions of agriculture that had occurred in Africa by 5000 B.C.E. and was the second invention that had occurred in the Horn of Africa. Although ensete cultivation began in the southern highlands with proto-Omotic cultivators, it spread into the northern and central highlands.

By 2500 B.C.E., agriculture had become increasingly intensive in nature. The Highlands Eastern Cushite agropastoralists developed a system of irrigation at about the same time that three other important agricultural techniques—terracing, fertilizing, and plowing—began to be used in the area. These techniques, used in combination, facilitated agricultural intensification, allowed for longer continuous cultivation of a plot of land without leaving it fallow, and increased yields. Stone and mud-wall terracing, which created new land on steep slopes, began to be employed in the highlands between the third and second millennia B.C.E. Terracing also helped farmers minimize soil erosion. The plow, which had spread from the Middle East via Egypt into the highlands, was used in the regions of Ethiopia in which volcanic topsoil provided a buffer (this type of land is not typical of most other regions of Africa). The presence of the plow and of wheat and barley demonstrate the ways in which culture and economy moved across large world regions even in ancient times.

With these varied agricultural practices, the Highland Eastern Cushites were able to prepare more of the increasingly dry Rift Valley lands for cultivation. The Highland Eastern Cushites expanded their settlements the length of the valley along the highlands and carried these innovations to new regions. Neighboring populations adopted combinations of fertilizing with manure, plowing, terracing, and irrigation. By the mid-second millennium B.C.E., Omotic and Eastern Cushitic populations in both the highlands and lowlands of southern Ethiopia had incorporated these practices to varying degrees. In the lowlands, populations such as the Eastern Cushites, Proto-Oromo, and Omo of the Tana River region continued to grow grain crops and raise livestock using the new techniques of intensification. They traded their lowland products for crops and products that could not

be produced in the dry lowlands, even with irrigation. Meanwhile, in the southern highlands, unlike in the north, rainfall remained at levels conducive to the cultivation of ensete.

The interactions among the populations of Omotics, lowland and highland Cushites, Nilotes, and Sudanians in northeastern Africa demonstrate how diverse and complex this region was culturally and economically in ancient times. The Ethiopian highlands was a region in which new agricultural ideas were being invented or adapted and put into practice as early as the seventh millennium B.C.E., and at the same time, it was a region from which ideas and products were diffusing to other parts of the world.

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■ C. 5500-C. 4500 B.C.E.

HALAFIAN CULTURE ADVANCES MESOPOTAMIAN AGRICULTURE

Halafian culture, transitional between farming villages and early cities, developed increasing social and technological complexity, including sophisticated ceramics, perhaps draft animal power, burial ceremonialism, and mud-brick architecture, with defensive works.

LOCALE: Northern Mesopotamia (now northern Iraq, northern Syria, and southern Turkey)

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Draft animals

SUMMARY OF EVENT

Early twentieth century archaeological work recognized the high-quality ceramics associated with the Halafian period. Between 1911 and 1929, Max von Oppenheim worked at Tell Halaf on the Syrian-Turkish border, roughly 205 miles (330 kilometers) northeast of Aleppo, Syria. Large quantities of pottery were recovered, and several occupations of the site were exposed. The earliest settlement was a sixth millennium B.C.E. community that provided the name for the broad cultural distribution that stretches across northern Mesopotamia. During the 1930's, the excavations of Max Mallowan (the husband of mystery writer Agatha Christie) at Arpachiyah, a small agricultural village about 3.5 miles (six kilometers) east of Nineveh (near Mosul, Iraq), contributed to the chronological positioning of the Halafian culture in the Mesopotamian sequence, in addition to describing the ceramic trends. Since the period of Mallowan's work, important fieldwork has been accomplished by Iraqi, British, Russian, and American archaeologists. Although considerable substantive information has been recovered on the cultural and technological aspects of the Halafian period, problems persist regarding understanding both the mechanisms responsible for the diffusion of Halafian culture and the political and social organization of this evolving agrarian economy.

Halafian agricultural villages were situated in fertile regions; however, sites were not always located in proximity to major tributaries. In most areas, annual rainfall was adequate to permit nonhydraulic farming. Halafian village sites vary in size: Domuztepe in southern Turkey is about eight acres (twenty hectares); Tell es-Sawwan in Iraq is about 26,000 square yards (about 24,000 square meters). Population numbers for Halafian villages are estimated at between thirty and two hundred individuals. During the immediate post-Halaf at the site of Domuztepe, however, the population may have approached fifteen hundred to two thousand individuals.

The Halafian agriculturalists were engaged in a mixed farming economy. At Tell es-Sawwan, rudimentary irrigation was initiated. Crops grown included wheat, barley, lentils, flax, vetches, and chickpeas. A number of wild species were also collected, including pistachio and ryegrass. Domesticated fauna included sheep, goats, cattle, and pigs. Wild faunal remains from Halafian sites suggest the importance of hunting for furs or meat. Patty Jo Watson and Steven LeBlanc, excavators of Girikihaciyan in southeastern Turkey, have suggested that cattle may have been used to pull plows, as they were kept alive longer than other domesticates. Another reason for their longevity may be tied to the development of dairy activities.

The proximity of Tell es-Sawwan to the Tigris River and fish remains recovered attest to the dietary variability of the Halafian people, which reflected their local environmental resources. Fish remains, however, are not common in Halafian sites.

Halafian cultural remains include various stone tools for processing cereals (grain grinders, pestles, and mortars), axes, mace heads, and bowls constructed from obsidian, alabaster, and sandstone. Spindle whorls, pendants, beads, zoomorphic figurines, a variety of bone and horn tools, and flint blades and scrapers suggest a tool kit consistent with expanding economic and ceremonial functions. Ovoid clay pellets discovered at different sites have been interpreted as sling missiles, perhaps used for defensive purposes.

Halafian ceramics are among the most sophisticated to be produced in prehistory. Pottery was fired evenly at about 900 degrees Fahrenheit (482 degrees Celsius), giving it a porcelain-like finish. Colors range from red to orange and black to brown. Vessels and plates used for ceremonies and special occasions were particularly



Arab women washing wool along the banks of the Tigris River at Mosul, an Iraqi town near the former center of the ancient Halafian culture. (Library of Congress)

spectacular in design, while others remained unpainted. The Burnt House at Arpachiyah, excavated by Mallowan during the 1930's, provided ceramic examples that established the Halaf as a period of high technical achievement. Ceramics—bowls of varied styles, jars, and plates—were produced in large quantities and bore geometric, zoomorphic, and anthropomorphic motifs. At Yarim Tepe II in Iraq, the earliest pottery kilns were excavated by a Russian expedition and dated to the fifth millennium B.C.E. Halafian culture was engaged in incipient metallurgy: Small copper artifacts, as well as copper ore, were discovered at Yarim Tepe II.

Halafian village architecture does not suggest deliberate planning. Domestic structures are circular or rectilinear. Stone foundations were used on certain, but not all, units. The use of mud brick dates to the sixth millennium B.C.E. in northern Mesopotamia and is the basic construction material. The earliest Halafian dwellings were round, slightly over one yard (one meter) in diameter, with a domed or flat roof. In the fifth millennium B.C.E., rectangular, single-story

structures of varied dimensions are the usual architectural form. Houses were small: At Girikihaciyan, circular dwellings ranged from about 2.5 to about five yards (2.25 to 4.5 meters) in diameter. Individual rooms within rectangular structures at Yarim Tepe II were about two yards (1.65 meters) by slightly over one yard (1.2 meters) in width. Halafian buildings embraced a range of shapes and room sizes: At Tell Sabi Abyad in northern Syria, one structure was twelve yards (eleven meters) long by 3.5 yards (three meters) wide and contained long, narrow rooms. It was common to plaster floors and occasionally walls by using a gypsum-based material.

SIGNIFICANCE

Although Halafian agricultural villages convey the appearance of small mud-brick domesticate units, ovens, kilns, and granary structures, the culture approximates an intermediate stage between the small Neolithic food-producing village and the first true Mesopotamian cities. A number of evolving institutional formats attest to this: trade, craft production, property control, ideological orientation, and defense.

Regional trade, a feature of early civilization, was present in Halafian culture and is evidenced by the movement of obsidian from volcanic sources to communities that processed the raw material into a variety of products, including bowls, tools, and plaques. In addition, Halafian ceramics were distributed over northern Mesopotamia.

The use of stamping seals has an ancient lineage in Mesopotamia, including in Halafian culture. Seals of lithic (stone) material and of various shapes bore geometric motifs. These seals may reflect a developing social hierarchy that controlled certain forms of property. By late Halafian times, seals increased statistically in the archaeological record, and they probably mark an institutional transition to more complex forms of economic administration.

Halafian sites have yielded a variety of implements used in weaving: spindle whorls, bone needles, and awls. At Domuztepe, both sheep and goats were managed into advanced ages, implying that wool and hair may have been important agricultural commodities. Weaving would appear to be an element of Halafian technological development designed to meet the needs of an expanding population.

Halafian archaeological sites document the high degree of craftsmanship and technical development in stone, seals, pottery, and figurine production. Evolving social and cultural institutions are further evidenced in a complex mortuary cult. At Yarim Tepe II, burials were of numerous types: cranials, secondary, and cremations. Burial offerings of animal remains and artifacts were placed in prepared chambers. At Tell es-Sawwan, the sixth millennium B.C.E. cemetery containing four hundred graves provided evidence on a spectrum of fertility symbols and assorted offerings. D. G. Youkana, an excavator at Tell es-Sawwan, suggested that this site was the center of a mother goddess cult that stretched across northern Mesopotamia. Additionally, the economic importance of cattle may have ceremonial parallels. Artistic representations of cattle (bucranium motifs on pottery) suggests cult activity, similar to the cattle cult at Çatalhöyük, an agricultural settlement in south-central Turkey that lasted from about the eighth to the fifth millennium B.C.E. However, cattle cult shrines have not been excavated in Halafian sites.

The presence of defensive works at Tell es-Sawwan reflects increasing patterns of social complexity. A mud-brick wall, 151 yards (138 meters) in length, and a moat reveal the inhabitants' concern for safety. Clay balls, perhaps sling missiles, were discovered in the moat.

Increasing patterns of leadership and community organization in the Halaf culture are reflected in the transport and manufacture of craft and construction materials. Cooperative labor projects are obvious in trade, agriculture, and edifices such as the Tell es-Sawwan defensive wall. However, Halafian culture lacks public architecture, occupational specialization, and elaborate social divisions based on wealth, power, and prestige.

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■ C. 5500-C. 4500 B.C.E.

NIGER-CONGO PEOPLES SPREAD AGRICULTURE IN AFRICA

Niger-Congo peoples spread both mixed agriculture and systematic agriculture and laid the foundation for advanced civilizations in West Africa.

LOCALE: Western and central Africa

AGRICULTURAL ISSUES: Climate change; Diet, nutrition, and cuisine
Population growth; Tropical produce

SUMMARY OF EVENT

According to most scholars, the earliest plant domestication for food occurred around 10,000 B.C.E. in different parts of the world. This transition from food gathering to food production constituted an agricultural revolution, taking place simultaneously in various parts of the world. In Africa, this major change in food production probably took place in Egypt close to 8000 B.C.E. Cereals produced in Egypt and later transferred to the Niger-Congo region differed from the Asian grains, which required more rainfall.

About 5500 B.C.E., people living along the banks of the Niger and Congo rivers in western and central Africa slowly transformed their lives. They transitioned from hunter-gatherers who practiced minimal agriculture along the western and southern regions of the Sahara to an expanding population of farmers who cultivated cereals, including millet and sorghum, in western and central Africa.

The Niger-Congo peoples had begun cultivating yams around 8000 B.C.E. They later domesticated okra, oil palms, black-eyed peas, and guinea fowl, using digging-stick agriculture rather than mound agriculture. In a region in which tropical rainfall softened the ground, stick agriculture predominated. Agricultural tools—an axe, hoe, and sickle—were also most likely in evidence by this time period. By about 6000 B.C.E., Niger-Congo peoples planted cowpeas, cereals, and root crops, including potatoes and yams. However, as the climate in the Sahara changed and the area became drier, the food producers moved deeper into the rain-forest zones of West Africa and

even to the Atlantic coast. These changes in climate forced an environmental adaptation but promoted the spread of agriculture by the Niger-Congo peoples from the fringes of the Sahara into the more tropical zones of western Africa.

Other bands of Niger-Congo peoples moved into the areas along the equatorial belt. Farmers began cultivating grain crops such as millet and sorghum. These cereals most likely arrived in the region from Egypt, the site of Africa's first food-producing economy. Millet and sorghum thrived in the tropical rain-forest region of West Africa, particularly along the banks of the Niger and Congo rivers. This advanced agriculture laid the foundation for population growth among the Niger-Congo peoples.

The Niger-Congo population in this region is estimated to have been about 500,000 or less by 6000 B.C.E. However, because of the increased food supply stemming from organized agriculture, it rose to about one million inhabitants by 1000 B.C.E. The sustainable population, based on food production, mixed agriculture, and a higher fertility rate (which usually accompanies an improved diet), could have



An important early West African grain crop, sorghum is now grown all over the populated world; it remains one of West Africa's most important food crops. (©SofiaWorld/Dreamstime.com)

been even larger, perhaps 1.5 million people. In addition to a greater food supply, the Niger-Congo peoples also came to depend on mixed agriculture, producing large herds of domesticated goats, cattle, and sheep. Large herds of such animals were present in the central Sahara by 7000 B.C.E., but domesticated animals did not reach the Niger-Congo region until sometime around 5000 B.C.E. Slowly, large herds of domesticated animals spread from western and central Africa into South Africa, virtually covering the entire continent by 1000 B.C.E.

Mixed agriculture, in addition to systematic agriculture, led to the population explosion among the Niger-Congo peoples.

The changing climate forced the Niger-Congo peoples even farther from the Sahara, causing more resettlement along the banks of the Niger and Congo rivers and their tributaries. Some groups moved into central Africa, close to the present-day Congo Democratic Republic. Wherever the Niger-Congo peoples spread, they took with them the agricultural technology necessary to spread the cultivation of cereals and other crops. The spread of systematic agriculture into new regions fostered diverse systems of food production that led to settled communities elsewhere in Africa.

Systematic agriculture entailed using hundreds and perhaps thousands of people in an organized manner to produce food. Many crops, especially millet and sorghum, were labor-intensive; that is, they required a large number of workers to produce small yields of food. However, systematic agriculture among the Niger-Congo peoples in Central and West Africa led to settled communities, far more advanced than the hunter-gatherers who preceded them.

SIGNIFICANCE

Systematic agriculture and its spread by the Niger-Congo peoples into the tropical rain forest along the western and southern Sahara laid the foundation for the powerful civilizations of Ghana, Mali, and Songhai. Niger-Congo peoples organized around agriculture became the most significant development in West Africa before the formation of the great Sudanic kingdoms.

Jackie R. Booker

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■ C. 4000 B.C.E.

HORSES ARE DOMESTICATED IN CENTRAL ASIA

People in Turkistan domesticated the horse, which became a valuable source of labor and transport in Central Asia and much of Europe and later played a crucial role in the military forces of the Greeks and Romans.

LOCALE: Turkistan (now Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan, south Kazakhstan, western China, and northeast Afghanistan), Central Asia

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Draft animals

SUMMARY OF EVENT

Strangely enough, the horse was among the last important animals to be tamed. Although it is not possible to pinpoint when horses were first domesticated, a reasonably close estimate can be made. As long ago as the Solutrean period of the Old Stone Age, perhaps nearly twenty thousand years ago, European wild horses were hunted so eagerly as big game that they were apparently brought to extinction in parts of Europe. There is no evidence that any efforts were then made to tame these animals despite their appearance in primitive statuary and cave paintings.

For tens of thousands of years, the homeland of the true horse was the north European plains and the western Asiatic steppes. Other forms of equids were distributed throughout the grasslands of Asia and Africa, but because there was no significant overlapping of their ranges, distinct species evolved; the hemionids, such as the onager, inhabited southwest Asia, the true asses lived in north Africa, and the zebras claimed east and south Africa.

Two types of wild horses survived in the Old World. One of these, known as Przewalski's horse, evolved in Mongolia (where wild survivors may still exist) but spread into southwest Asia and eastern European grasslands after the retreat of the last of the Pleistocene ice. Przewalski's horse is a heavily built animal with sturdy short legs; its

head is large and mulish in appearance, and it stands about thirteen hands high. The other type of horse, the tarpan, evolved in south Russia, although it was known archaeologically and historically to central Sweden and the North Sea coast. It survived in the Ukraine until the mid-nineteenth century. Generally smaller than the Mongolian wild horse, the tarpan had a stiff upright mane and a dark stripe extending from mane to tail on its mouse-gray body. It was systematically hunted to extinction by Ukrainians because wild stallions enticed domesticated mares away from the farms.

Present-day evidence strongly suggests that tarpan stock was the principal contributor to the modern domesticated horse, although some authorities consider Przewalski's horse to be the dominant strain. Because these two horse ranges overlapped in eastern Europe and Turkistan, it is possible that the modern horse is descended from a mixture of the two. Genetic studies, however, have established that Przewalski's horse has a different chromosome number ($2n = 66$) from all types of modern horses ($2n = 64$). This fact strengthens the claim for the tarpan contribution being the greater of the two. This question cannot be resolved because the tarpan is extinct and its chromosome number cannot be determined. All present-day Mongolian ponies have come from the West. There is still debate whether the heavy Western European draft horse was derived from tarpan stock or from some yet undiscovered large type of horse. A heavy-boned Pleistocene horse has been found in glacial deposits in Western Europe, but it is known neither archaeologically nor historically. Horse bones do not show any singular osteological changes concomitant with domestication as do the horns of sheep, goats, and cattle.

Although the first historical writings that mention horses as being usefully employed by humans date from about 2000 B.C.E., it seems safe to infer that the horse had already been domesticated for at least two millennia by that time. Camels and dromedaries were being domesticated around the same time. After 2000 B.C.E., there are numerous literary references to the horse in addition to various representations in statuary and paintings. An educated guess for the beginnings of horse domestication is about 4000 B.C.E.

On the basis of the distribution of the true horse six thousand years ago, it appears that the area in which domestication was first tried was Turkistan in Central Asia. Perhaps around 3000 B.C.E., small



In Central Asia, as in the Middle East, South Asia and North Africa, camels have long been important draft animals, along with horses and their kin. (Library of Congress)

numbers of domesticated horses diffused to eastern and north-central Europe. About the same time, the same type of horse appeared in the Iranian plateau, and it appeared a little later in Bronze Age cultures of the Near East.

SIGNIFICANCE

Since its domestication, the horse has served humankind as a means of transportation and as a source of labor during both war and peacetime. The first application of the horse as an aid to humankind was in the dubious role of chariot puller. The chariot, developed from the two-wheeled cart originally drawn by cattle, had obvious strategic value in giving greater mobility to a single warrior. When this vehicle was introduced into Egypt by the Hyksos in 1788 B.C.E., the accompanying horses were almost certainly of Asian origin but of tarpan ancestry. They were rather large in size but delicate in head and body build and bay or black in color. These animals were the progenitors of the Nubian horse, the strain from which the Barb of Morocco was derived and whose genes may still be viable in some modern thoroughbreds, hunters, remounts, and plow horses. The chariot was in use in Greece in 1000 B.C.E. but survived in Julius Caesar's Rome mainly for ceremonial occasions and for races.

Riding astride the horse may have begun in Turkistan before 3000 B.C.E. Cavalry, an integral part of the Greek fighting force by 800 B.C.E., became a dominant force in the Roman fighting machine. Continuing through feudal times in Europe until the beginning of World War II, the development of several new breeds of horses was influenced by military needs.

As a source of labor, horses have contributed greatly to improving the quality of human life; however, many scholars believe that the horse's greatest influence on history has been in warfare. Classic events such as the Battle of Poitiers in 732 C.E. when Charles Martel defeated the Saracen invaders, and the Siege of Tenochtitlán by the Spaniards in 1521, may well have been changed by the presence of horses.

Fred B. Kniffen

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■ C. 4000 B.C.E.

RISE OF SUMER IMPROVES MESOPOTAMIAN AGRICULTURE

Building on an agricultural system developed by earlier societies, the Sumerians created complex political, economic, social, and cultural superstructures and therefore came to be regarded as one of the world's earliest civilizations.

LOCALE: Mesopotamia (now Iraq and parts of Iran, Syria, and Turkey)

AGRICULTURAL ISSUES: Archaeological discoveries; Innovations; Irrigation and water management; Marketing and trade; Population growth

SUMMARY OF EVENT

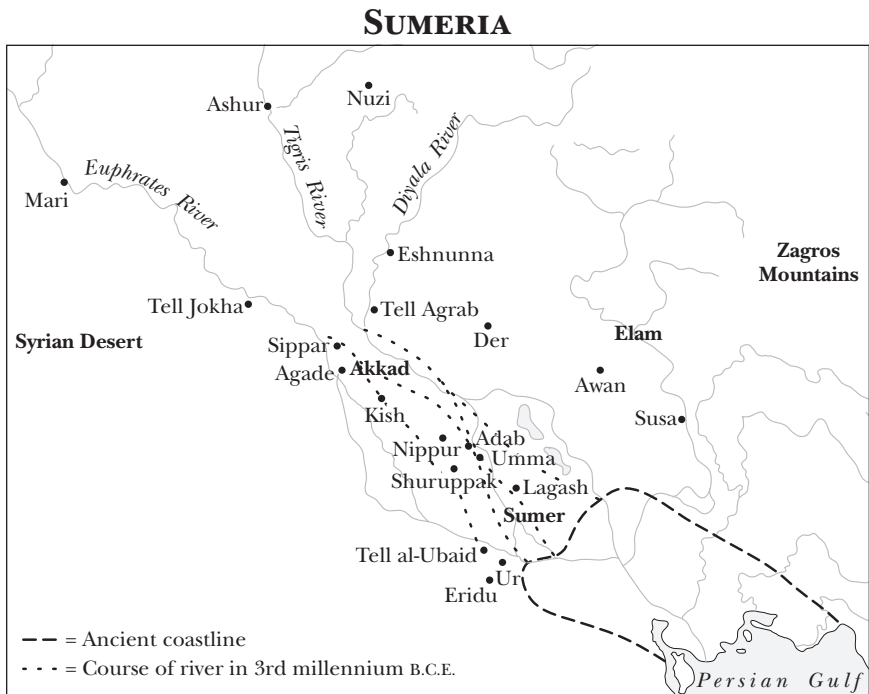
“Mesopotamia”—a word derived from the Greek term for “land between the rivers”—describes what many historians define as the world’s earliest civilization. This civilization arose between the Tigris and Euphrates rivers, a mess of mud, clay, and reedy swamps roughly two hundred miles (320 kilometers) long and one hundred miles (160 kilometers) wide (at its widest point). This area was subject to torrential rainstorms, periodic flooding, sweltering heat, and blazing sunlight. By 6000 B.C.E., the agricultural revolution brought settled Neolithic societies to the hilly north and to the mountains east of Mesopotamia, but not until a thousand years later were agricultural techniques sufficiently understood for a few adventuresome peoples to migrate into these inhospitable river plains. It would take another thousand years for the Sumerians to build on the work of previous cultures and turn a scattering of settlements into a series of thriving city-states.

In central Mesopotamia, the Samarra culture (5500-5000 B.C.E.) established agricultural settlements. Houses, built with mud and clay bricks, appear to have contained about ten rooms. Ceramic wares and grain were traded for copper (used in jewelry) and for semiprecious stones such as obsidian and turquoise. By 5000 B.C.E., a few small settlements extended into southern Mesopotamia. In northern Mesopotamia, Halafian culture (5500-4500 B.C.E.) established settle-

ments, which took the form of a large number of tiny communities, and the Halafians engaged in extensive trade of their distinctive pottery.

The Ubaid people (named after Tell-al Ubaid in southern Mesopotamia near what would become the city of Ur and now is Muqaiyir) are generally credited with the settlement of southern Mesopotamia and the creation of more complex towns. Use of the slow wheel and unlimited access to clay resulted in the production of large amounts of greenish colored pottery decorated with brown or black geometric designs and loop handles. This distinctive pottery appears to have eclipsed that of the Samarrans and Halafians in popularity.

The Ubaid people developed irrigation and marsh-drainage techniques to allow them to practice agriculture along the Tigris and Euphrates rivers. Without irrigation and canals, the fierce storms that struck during the spring and caused the river to flood would have made planting impossible. The rich mud of the plains produced bountiful crops of barley, lentils, and wheat. Fired clay was used to



create hoes, adzes, sickles, and other tools. They raised cattle, largely as work animals; sheep for wool; and goats for their milk, which was turned into cheese. Like the Samarrans, the Ubaid people built houses made of molded sun-dried mud brick. However, unlike the Samarran settlements, Ubaid towns kept on expanding in both size and complexity. By 4500 B.C.E., towns numbering several thousand inhabitants were not uncommon. The largest of these was Eridu (site south of present-day An Nāsiriyyah, Iraq), which had houses crowded together, forming narrow alleyways. Houses were built on a tripartite plan: A full-length large rectangular room was flanked with rows of smaller rooms on each side. Larger houses, apparently constructed for the upper class, contained storage facilities. Eridu also contained a large, richly decorated temple built of mud brick and supported by complicated buttresses and niches. This temple was first excavated by Sir Leonard Woolley in 1922. The simplest houses, often composed of reed, were reserved for the farmers who lived on the outskirts of Eridu.

Because mud bricks are weakened by rain, buildings in Eridu and other Ubaidan settlements lasted no longer than a generation. Each rebuilding seems to have resulted in larger buildings, general expansion of the size of the town, and much larger temples (suggesting that irrigation projects were directed by a priestly elite). Trade for precious stones extended to distant India and down into the Persian Gulf and modern-day Saudi Arabia, where a number of Ubaid trading outposts were constructed. To direct northern trade, Ubaidans constructed Tepe Gawra (discovered in 1927 by the archaeologist Ephraim Speiser, near modern Mosul, Iraq), which contained three large temples similar to the one found at Eridu. By 4300 B.C.E., when the Sumerians arrived on the Mesopotamian river plains, they catalyzed a process already in motion of producing sophisticated, ever-expanding towns with linked agricultural and trading communities.

The Sumerians, who called themselves “the black-headed peoples,” spoke a monosyllabic language unrelated to any other language group. Their origins (probably India, Persia, and the area around the Caspian Sea) and relationship to any other known ethnic group have yet to be determined. The Sumerians soon dominated and eclipsed their Semitic-speaking neighbors. They introduced improved and new techniques that led to continued population growth

and urbanization, resulting in what can be called the advent of civilization.

Sumerian innovations included the building of roads on which donkeys brought goods to market and canals to more efficiently irrigate fields and to facilitate the transportation of goods by boat. The Sumerians were building the infrastructure necessary for complex urban life. They invented the quick wheel for the mass production of pottery. They built channels, dikes, and reservoirs for flood control and water conservation.

Considerable care was devoted to the cultivation of dates, trees that do not self-pollinate and require five years of nurturing before they produce their high-energy and vitamin-laden fruits. Evidence suggests that a priestly class might have had a role in directing economic activity and extracting tribute in return. Record keeping began in the form of clay tokens imprinted with the characteristic seals of the two parties involved in a contract. Other inscriptions probably denoted the item involved and represent pre-cuneiform writing. The shape of the token denoted the quantities involved (small cone = one, circle = ten, large cone = sixty). In this way, the Sumerians were developing mathematical systems in addition to record keeping and writing.

By 4000 B.C.E., Uruk (called Erech in the Bible and identified as Warka in modern Arabic; site northwest of modern-day Muqaiyir, Iraq) began to emerge as the major Sumerian center, a model for what would become, over the course a millennium, twelve major Sumerian city-states. The city-state appears to have resulted from the merging of two neighboring settlements, Kullaba and Eanna. The city was dedicated to the goddess of love, Inanna (later called Ishtar), and a mound temple was built to honor her. Inanna had been the patron goddess of Eanna. Another temple was dedicated to the sky god Anu, the patron god of Kullaba. Both temples were based on the Ubaid style, and both were rebuilt many times, forming two of the several ziggurat temple complexes in Uruk. Security considerations also came to the fore, and work began on a wall that was to surround the city (eventually reaching six miles, or 9.5 kilometers, in length) and was to be surrounded by a moat for further protection. The semilegendary first king of Uruk, Gilgamesh, is credited with completing the walled fortifications.

C. 4000 B.C.E.

SIGNIFICANCE

Organized human activity was able to overcome harsh environmental obstacles and exploit the agricultural potential of the fertile Mesopotamian plains, creating a population explosion in a limited geographic area. The resulting food surplus sustained increasing numbers of artisans, craftspeople, and merchants living in continually expanding urban centers. Capitalizing on developments over the previous thousand years, the Sumerians introduced new advances, resulting in the creation of Uruk, an urban center large enough to be considered the world's first city-state. Located on the Euphrates River, Uruk was a seminal influence for the development of other Sumerian city-states such as Ur, Kish, and Lagash. Through wide-ranging trade by land and sea, the Sumerian civilization influenced the development of civilization in other Middle Eastern as well as Asian societies. Although the process of civilization was taking place in other river-based agricultural societies, Mesopotamia was transformed earlier and more extensively. Rapid population growth, urbanization, complex social stratification, and extensive trade were first experienced by the Sumerians in Mesopotamia; these steps toward civilization would be followed elsewhere. For this reason, Mesopotamia has long been regarded as the cradle of civilization.

Irwin Halfond

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■ C. 2600 B.C.E.

LEIZU DISCOVERS SILK MAKING

An ancient and perhaps legendary Chinese empress discovered the technique for unwinding silkworm cocoons and weaving them into fabric.

LOCALE: China

AGRICULTURAL ISSUES: Archaeological discoveries; Innovations; Textile industries

KEY FIGURE:

Leizu (Si Ling-Chi; fl. c. twenty-seventh century B.C.E.), Chinese empress who discovered silk making

SUMMARY OF EVENT

China has long been associated with the production of silk, to the point that ancient Egyptian writers referred to it as *Serica*, literally “the land of silk.” The Chinese so closely guarded the secrets of silk that the Roman historian Pliny the Elder (23-79 C.E.) wrote that it was produced by washing downy fibers from leaves. So old is sericulture (the techniques surrounding the raising of the silkworm moth, *Bombyx mori*, and the unwinding of its cocoons for silk fiber to be woven into fabric) that its origins have become surrounded by myth and legend.

However, one person is generally singled out as having first discovered that a silkworm cocoon could be unwound to make fiber. This is Leizu, who was either a wife or a concubine of the celebrated Yellow Emperor Huangdi (Huang-ti, c. 2704-c. 2600 B.C.E.) in 2640 B.C.E. According to the most common versions of the story, she went to retrieve a cocoon that had fallen into a cup of hot water (some versions say it was tea that she had been making while in the gardens of the Imperial palace). When she withdrew the cocoon, she and all her court were astonished to discover that it came out hanging from a delicate silken thread. The heat of the water had dissolved the gummy substance known as sericin that the silkworm moth uses to bind the silken thread into a solid cocoon and thus enabled the silk fiber to be reeled up for weaving. Although the discovery is generally said to

have been an accident, other versions of the tradition suggest that Leizu's husband had assigned her to study the possibility of weaving a useful fiber from silkworm cocoons.

Leizu is said to have developed the techniques by which silkworms could be raised in controlled conditions and invented looms and other equipment with which to transform raw silk fiber into the beautiful, sensuous cloth for which China would become famous throughout the world. So extensive was her contribution to the production of silk that she was deified and joined the sizeable Chinese pantheon as Shantzen (Sien-tsan), the goddess of silkworms. This apotheosis further contributed to the blurring of historical fact with legend, making it difficult if not impossible to determine the boundaries of each.

Archaeological finds have hinted at the substance behind these legends. In 1927, half a silkworm cocoon was unearthed from soil near the Yellow River in Shanxi Province of northern China. It was radiocarbon dated to be from between 2600 and 2300 B.C.E. More recent discoveries have suggested that the beginnings of sericulture and silk weaving may date even earlier, perhaps by as much as one thousand years, although these finds are hotly debated in the archaeological community.

Over the centuries that followed Leizu's discovery, the silkworm became a truly domesticated insect, and selective breeding made it exceedingly docile and incapable of surviving in the wild. The adults became incapable of flight and uninterested in flying away from their cocoons, while the caterpillars became gregarious with no tendency to wander from their feeding beds, as do related species. These transformations made it easier to handle the valuable insects because it was no longer necessary to fully enclose the chambers in which they were raised, as would be the case with a more mobile species.

During the early years of silkworm culture, only members of China's imperial family were permitted to wear silken garments or use items made of silk. However, as time passed, restrictions were relaxed and other aristocrats and officials were permitted the privilege of using this high-status fabric. Ultimately even ordinary people wore silk, and the fabric was used as money during some eras of Chinese history. Eventually, Chinese emperors discovered that a substantial fortune could be made from selling silken cloth abroad, and by the

Japan borrowed silk making from the Chinese and added its own refinements. This print by Utamaro Kitagawa (1753?-1806) shows Japanese women working with trays of silkworm cocoons. (Library of Congress)



second century B.C.E., the famous Silk Road had come into existence. This trade route or set of trade routes, stretching across Asia, brought not only silk but also other exotic Asian goods such as tea and spices to Western Europe and northern Africa. Although China sought to maintain a complete monopoly on the production and sale of silk, within a few centuries, brave spies risked their lives to smuggle live eggs and cocoons abroad. After that point, the primary limit on the growth of sericulture would be the availability of fresh mulberry leaves and willing workers for this labor-intensive industry.

SIGNIFICANCE

Until the development of modern synthetic fibers in the nineteenth and twentieth centuries, silk remained the strongest and finest fiber available for making cloth. These characteristics, as well as the labor-intensive methods of raising silkworms, gave silk a reputation for richness and a symbolic association with wealth and power. At the same

time, silk was also used in certain precision instruments, such as the cross-hairs of the finest scopes.

Leigh Husband Kimmel

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■ **C. 1000 B.C.E.-C. 100 C.E.**

ADENA MOUND BUILDERS ESTABLISH A FARMING SOCIETY

The Adena were a prehistoric farming society in North America who left evidence of their lives in the mounds they constructed.

LOCALE: Ohio River Valley (in Ohio, Indiana, Illinois, West Virginia, Kentucky, New York, and Pennsylvania)

AGRICULTURAL ISSUES: Archaeological discoveries; Diet, nutrition, and cuisine

SUMMARY OF EVENT

The Eastern Woodland period, which began around 1000 B.C.E., was characterized by several developments, the most notable of which was the introduction of an early form of agriculture. The Adena were an Early Woodland people who lived around the Ohio River Valley from about 1000 B.C.E. to 100 C.E. Evidence of Adena settlements has been found in Ohio, Indiana, Illinois, West Virginia, Kentucky, New York, and Pennsylvania. The Adena lived in an environment of dense forests, rich with game and foraging foods, drained by numerous rivers and streams. The weather changed significantly during the year from cold, harsh winters to hot summers. However, the length of the growing season, the rich soil, and ample rainfall proved well suited for farming.

The Adena are most noted for the hundreds of earthen effigy mounds they left behind. These large hills varied in size from a few feet to hundreds of yards across and hundreds of feet tall. Most Adena mounds are circular, but some were constructed in geometric and animal shapes, and others were surrounded by moats, walls, or embankments. The most famous of these and one of the longest, the Serpent Mound near Cincinnati, Ohio, is a series of mounds, twenty feet (seven meters) wide and five feet (nearly two meters) tall, that stretch almost a quarter of a mile (nearly half a kilometer). From the sky, the mound appears to be an open-mouthed snake.

Thousands of mounds once dotted the Ohio River Valley. Over

the years, many were destroyed, cleared away by early nonnative farmers or raided by the curious. Hundreds remained, however, and both professional and amateur archaeologists have excavated many of them. Through the examination and study of the artifacts found inside, archaeologists and anthropologists have learned much about the foods the Adena ate, the clothing and jewelry they wore, the tools they used, and even how they may have worn their hair.

A great deal of labor and organized community effort was used to construct the mounds. The Adena moved thousands of tons of earth to the sites using only woven baskets to carry the soil. The mounds were constructed for various purposes. Some were dumping places for tribal garbage. Some mounds are believed to have had religious or ritual significance, and celebration headdresses and masks were unearthed from small interior dwellings that were possibly ceremonial rooms or buildings. The mounds might have begun with a round dwelling house that was converted into a mortuary.

Most Adena mounds were used as burial sites for the dead and contain human and animal remains along with various grave goods, including copper beads and bracelets, carvings on stone tablets, river pearls, mica, weapons, tools, cooking utensils, and pipes. Some pipes, weapons, and bowls were decorated with carvings of animals and humans. The human remains have provided scientists with clues as to the age, sex, and size of the Adena; when they died; and the causes of their deaths. Bodies of some of the dead were cremated before their ashes were placed in the mounds. Others were cached in hollow tree trunks or logs. Several graves contained small vaults constructed of wood or bark. A few of the bodies were decorated with headdresses, helmets, bracelets, pendants, and rings. Bodies dating to the end of the Adena era, c. 100 C.E., have been found sprinkled with powdered ocher derived from a red clay in the area that was also used to decorate pottery.

Some mounds were not completed after the first group of remains was interred. They contained multiple layers and dozens of bodies buried over many generations. The bodies were interred, sealed, and covered with another layer of earth. By excavating the mounds in horizontal slices, anthropologists have been able to track the progression of Adena culture over the years, revealing that as the centuries passed, the Adena developed more advanced tools and weapons, produced more refined jewelry, and made advancements in agricultural methods.

The Adena were some of the earliest Native American farmers. Cultivation may have begun when tribal people stuck seeds or nuts from foods they already gathered into the ground. If they bore fruit, the people planted more in areas closer to their villages. Agriculture supplemented the diets of the Early Woodland people rather than acting as their main source of nutrition. The Adena diet included hazelnuts, walnuts, and hickory nuts. They also appear to have eaten sunflower and goosefoot seeds, raspberries, strawberries, and grapes. Toward the end of the period, there is evidence that the Adena were planting the corn and squash that would later become staples for many Eastern American tribes.

The Adena continued to hunt and gather to supplement their diet. Many different animal bones were found in the mounds. Evidence suggests the Adena hunted deer, bear, elk, wolf, and small game such as raccoon, squirrel, and beaver. Fish and wild birds such as turkey, duck, and grouse were also a part of their diet. The Adena broiled or grilled their food over an open fire or boiled it in leather or wooden containers. Meals were eaten from wooden or stone bowls. Gourds were dried and used as bowls and spoons as well as eaten.

*One of the most
important game
birds hunted by
early Native Americans,
wild turkeys formed
part of the Adena diet.*
(©Bruce Macqueen/
Dreamstime.com)



Hunting tools included spears with pointed flint blades and stone knives for cutting and scraping. Spearheads were sharpened to a point by chipping away at flint with knife blades or other stones. Hides from hunted animals were used for clothing and blankets. Evidence indicates the Adena wove and twined local grasses for mats and sandal-like footwear.

The Adena lived in small, semipermanent villages. They used lumber from the forests around them to construct circular wooden homes. The outside walls were erected with sunken wooden tree posts that were pointed outward to support the roof. The outside walls were covered with bark or long, thin sticks interwoven into wattle for support and insulation. The conical roof was also constructed of wooden poles and covered with slabs of bark. Each home was approximately eighteen to forty feet (six to twelve meters) in diameter.

Pottery was found in a number of mound sites. Some anthropologists believe the Adena were one of the first tribes in the eastern United States to make pottery. Pottery was made from carved stone or clay that was abundant in the area. Clay was gathered from nearby creek beds, formed into bowls and pots, and dried in the sun. Many vessels were decorated with geometric and animal shapes. Serpent decorations were found carved into bowls and pipes and painted on pottery. Pottery was used for cooking and storing food and as eating utensils.

Evidence suggests that the Adena traded extensively with other tribes, including tribes hundreds of miles away. Grizzly bear teeth and obsidian from the Rocky Mountain region were found in the burial mounds along with copper from north of the Great Lakes and seashells from the coastlines of both the Atlantic Ocean and the Gulf of Mexico.

SIGNIFICANCE

It is not known why the Adena civilization disappeared. Somewhere around 100 C.E., the Adena may have dispersed or been driven away to other regions. They may have merged with the Hopewell tribe, another mound-building Eastern Woodland group that later occupied the same areas of the Ohio River Valley. The Hopewell constructed more refined metal tools and ornamentation and produced mounds that were even more elaborate than those of the Adena. However, the

artifacts the Adena left behind in the mounds they constructed provided future generations with vital clues about their culture and way of life.

Leslie Stricker

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■ C. 1000 B.C.E.-C. 300 C.E.

TRADE FOSTERS AGRICULTURE IN WEST AFRICA'S SUDAN BELT

Inhabitants of Africa's Sudan Belt cities and towns had extensive contacts with the Mediterranean regions through trade in a wide variety of goods, of which the most important were salt and gold.

LOCALE: Djenné, the Sudanic belt, the Sahel, and the Sahara

AGRICULTURAL ISSUES: Archaeological discoveries; Marketing and trade; Tropical produce

SUMMARY OF EVENT

Geographers and historians define the Sudan belt of the ancient world as the area that extends from the Sahara in the north to the Gulf of Guinea, below present-day southern Nigeria, in the south and from the Atlantic in the east to the Indian Ocean in the west. In the western part of this broad environmental region, in a subregion called the Sahel, Africans established towns and cities that served as inland ports between Africa's interior and coastal areas and the people beyond those areas.

Western Africa is characterized by several environmental zones. The Sahel, an Arabic word meaning "shore" or "coast," is located between the Sahara in the north and the rain forest in the south. It is a mixed zone of grass-covered plains (steppe), brush, thicket, and sparse forests (savanna). The ancients knew it as the southern boundary of the Sahara, a desert so huge it seemed to them to be a kind of "sea." Cities developed in the Sahel and prospered as a result of trade they carried on across the Sahara. Trade items from the Berbers of northern Africa—salt, textiles, spices, sword blades, and metal tools and utensils—were carried south across the Saharan "sea" on the backs of camels, animals ideally suited to endure long treks of thirty to forty days.

Of these trade goods, salt was the most valuable. Produced in salt mines in the Sahara, such as the one at Taghaza, salt was so valued—as a taste enhancer and preservative for food—that it was used as cur-

C. 1000 B.C.E.-C. 300 C.E.

SAHEL REGION WITH MODERN BOUNDARIES



rency. At various outposts along the way, the salt, spices, and sword blades were broken down into smaller or larger packages and re-packed for the next stage of the journey. Rests were taken at desert oases. The termini for the trade goods were the towns of the Sahel: Koumbi Saleh, Timbuktu, Gao, Kano, and Ngazaragamu. The goods were then traded for gold, ivory, animal hides, and slaves for the trip north. Farther south, traders transferred their loads into dugout canoes or used other modes of transport. In this way, they ventured to cities of the rain forest, where they were traded for bronze and iron items. Foodstuffs, in the form of rice, beans, sorghum, and millet, were also exchanged. Trade in iron weapons and tools was also important. The people of the Nok culture were smelting iron in western Africa by the first century C.E.

Several cities arose in the Sahel of western Africa that became famous as a result of trade and commerce carried on there: Dhar Tichitt, Djenné, Timbuktu, Gao, Mali, Ghana, and Walata. They comprised the leading commercial centers of the kingdom of Mali. The inhabitants of these centers were both local people and migrants from the north escaping the gradual spread of the Sahara Desert. The promise of productive farmland in the south lured them into the Sahel, and the growth of trade and trade routes hastened the migrations. As people moved from north to south and around subregions

within this larger region, they settled villages and towns, ostensibly with the aim of farming. Over time, however, the strategic locations of these towns and villages along Sahara, Sahel, and savanna trade routes led the inhabitants to turn from agriculture to trade. Gradually, they developed networks of interregional trade.

One of the earliest trading centers was Djenné (in present-day Mali). Located in the Niger River Delta, it was first settled c. 250 B.C.E. and grew steadily over the centuries. By 450 C.E., Djenné spread over at least sixty acres (twenty-four hectares). At first, the people of Djenné lived from herding, fishing, farming, and exchanging their produce with others within their immediate locale. Over time, circles of trade expanded. At the center of the regional trade was Djenné, where people would gather to exchange goods. Archaeologists have discovered Roman and Hellenistic beans in the remains of ancient Djenné, suggesting that these trade items were reaching West Africa.

SIGNIFICANCE

The trading cities of the Sudanic belt entered their peak during the Islamic era. These included Koumbi Saleh, a trading center for salt and gold in what was to become the kingdom of Ghana. Mined in the Sahara, salt was carried to Koumbi or Awdaghast. Koumbi became the liveliest trading center in West Africa. Salt and gold were the most important trading items, but other things were traded as well: cattle from the south, wheat from the north, cloth, leather goods, seashells (used for decoration and as currency), copper, and ivory. Craftspeople in Koumbi worked the gold and copper into jewelry or other items.

Gao, the city that became the capital of the Songhai Empire, rose up around 500 C.E. Its important trading items were salt and gold. Luxury items that flowed into Gao from trade included glass, copperware, and cloth.

The trade and commerce of the Sudanic Belt towns and cities of Africa extended over a wide area and touched diverse peoples. Berbers were among the main traders across the Sahara to the West African Sahel. Different groups within the Sahel rose up as vital traders of goods such as gold and iron and also produced some of the leading trade items, such as gold and ivory jewelry. Of all the trade

C. 1000 B.C.E.-C. 300 C.E.

items in the trans-Saharan trade, salt was the most important. Gold was also highly desired.

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■ C. 750-C. 500 B.C.E.

WATER FROM YEMEN'S MARIB DAM CREATES A RICH FARMING REGION

The construction of the Marib Dam in Yemen provided water for irrigation for nearly one thousand years and created a rich farming region on the edge of the desert in south-central Arabia.

LOCALE: Kingdom of Sheba, Arabian Peninsula (now Marib Governorate, Yemen)

AGRICULTURAL ISSUES: Irrigation and water management; Marketing and trade

SUMMARY OF EVENT

The area around the ancient city of Marib has been important commercially and agriculturally for several thousand years. Once known as Sheba (or Sabah, or Sabaa), the region lay on trade routes stretching by sea to the Persian Gulf and India and by land to Mesopotamia and the eastern shores of the Mediterranean. Equally important, Sheba was a rich agricultural region. The Old Testament of the Bible records a queen of Sheba, believed to have lived about 950 B.C.E., as visiting Solomon, king of Israel. The region now lies within the nation of Yemen in southern Arabia.

Heavy rains fall in Yemen only two or three times a year, briefly flooding the hills only to disappear into the sand or evaporate. In order to channel this water for farming, Sheba's inhabitants developed an extensive and sophisticated irrigation system, some of whose diversion dams and canals have been dated to the middle of the third millennium B.C.E.

The greatest component of Sheba's irrigation system was the Marib Dam, built about five miles (eight kilometers) west of Marib across the Wadi (watercourse) Adana. The Adana flows in a northeasterly direction from the eastern highlands of Yemen and gathers the runoff of many other wadis. The original earth dam, which was begun about 750 B.C.E., was about thirteen feet (four meters) high and 1,900 feet (580 meters) long. It fed water into a single, naturally



Modern Yemeni farmer using a donkey to plow his field. (©Robert Paul Van Beets/Dreamstime.com)

occurring spillway lying nearly 10 feet (3 meters) below the top of the dam and located between the northern end of the dam and a high cliff. The water then flowed into a basin 75 feet (23 meters) wide and 213 feet (65 meters) long in which silt could settle. A canal 92 feet (28 meters) wide and 3,068 feet (935 meters) long led from the basin to twelve separate ditches. As a result, Sheba's inhabitants were able to bring the land north of the wadi under cultivation.

Some two and a half centuries later, beginning about 500 B.C.E., the dam was heightened to twenty-three feet (seven meters). The slope of its sides now lay at about 45 degrees, and its upstream surface was faced with stone set in mortar to prevent seepage and erosion. A sluice was cut and an adjoining canal built at the dam's southern end, allowing for irrigation of the southern banks of the Wadi Adana. Later construction raised the height of the dam to forty-six feet (fourteen meters) and improved the irrigation system's efficiency.

SIGNIFICANCE

Thanks to the dam and its extensive series of canals, settling ponds, and ditches, much of the rainwater falling in the highlands of Sheba

was caught and channeled to the lands around Marib. Although the region lay at the edge of the forbidding desert known as the Rub al Khali, or Empty Quarter, it grew into a rich farming community. Some 24,000 acres (9,600 hectares) were brought under cultivation, an area large enough to feed as many as fifty thousand people. The region's farmers produced barley, maize, millet, dates, grapes, and other crops. The immense structure that made this possible came to be known simply as the Great Dam, and the fertile lands north and south of the Wadi Adana were known as the Garden of the Two Paradises.

The accumulation of silt and other debris was cleared from behind the dam every one hundred years. Unusually heavy floods overtopped the dam more frequently, approximately every fifty years, necessitating periodic repairs. However, the damage caused by a major flood in 575 C.E. was never repaired, and subsequently the dam washed away. The loss was devastating, an event so catastrophic that it is memorialized in the Qur'ān, the Muslim holy book. Most inhabitants fled the region.

Beginning in 1984, a new earth dam was built across the Wadi Adana upstream from the location of the ancient structure.

Grove Koger

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C. 750-C. 500 B.C.E.

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■ C. 500 B.C.E.-C. 200 C.E.

LIBYA'S GARAMANTES FLOURISH AS FARMERS AND TRADERS

The Garamantes harnessed the water beneath the Sahara, through networks of underground canals called foggara, to supply oases, where they carried on farming.

LOCALE: Northern Sahara Desert in present-day Libya

AGRICULTURAL ISSUES: Archaeological discoveries; Irrigation and water management; Marketing and trade

SUMMARY OF EVENT

The Garamantes were an ancient people who inhabited the Sahara Desert from around 500 B.C.E. to 200 C.E.

They lived in three large cities—the capital of Germa (ancient Garama), Zinchera, and Saniat Gebril—and in about twenty other settlements in the Fazzan, a region in the southwest of Libya. The remains of the Garamantes' settlements have been uncovered by archaeologists who believe the Garamantes were not nomadic people, as described by ancient historians, but were, in fact, an advanced civilization adept at building a 3,000-mile (4,840-kilometer) network of irrigation canals (*foggara* in Arabic) buried under the desert sands. The Garamantian canals tapped into aquifers beneath the surface of the Sahara and carried the precious water via low-grade gravity to nearby oases. In these oases, the Garamantes grew foodstuffs such as cereals, grapes, olives, and dates in quantities significant enough to allow them to survive, enlarge their settlements, and expand their control over the Fezzan.

Historians know very little about the Garamantes and their way of life. Scholars differ about their origins, with some maintaining that they were Berbers (a people of northern Africa linked through language) who made their way into the Sahara in the first thousand years B.C.E. Other scholars believe the Garamantes originated from a Neolithic people who lived in northern Africa when it was covered by lakes and inland oceans. Archaeologists have examined rock paint-

C. 500 B.C.E.-C. 200 C.E.

ings of humanlike stick figures hunting animals and existing alongside cattle to support their claim that the Garamantes evolved from a nomadic people who hunted to survive to a settled people who raised and herded cattle. Because livestock need reliable water supplies to survive, scholars believe that the Garamantes had access to such reserves.

At some point in their history, the Garamantes developed a method of constructing many hundreds of underground irrigation channels. In northern Africa, these desert irrigation channels are called *foggara*; in other areas of the Middle East they are called *qanat*. Where the Garamantes learned the technology of desert irrigation channeling is still a mystery, although scientists suggest they may have acquired the technique of oasis farming from the Egyptians and other peoples to the east. More puzzling is why and when the Garamantes abandoned the *foggara* and with them their settlements. Falling water levels in underground aquifers could be one reason.

Ancient historians, beginning with the Greek Herodotus (c. 484-c. 425 B.C.E.), depict the Garamantes in a variety of ways. In book four



The Awbari oasis, a rare fertile spot in southwestern Libya. Libya is a mostly arid region that requires intensive irrigation to make plant cultivation possible. (©Crobard/Dreamstime.com)

of his *Historiai Herodotou* (c. 424 B.C.E.; *The History*, 1709), Herodotus describes the salt hills of the Libyan interior and the streams that flow from them. The Garamantes, according to Herodotus,

are one of several tribes who are the last inhabitants of Libya on the side of the desert, living as they do, more inland than the wild-beast district. . . . The Garamantians, a very powerful people . . . cover the salt with mould, and then sow their crops. . . . The Garamantians have four-horse chariots, in which they chase the . . . Ethiopians.

In his *Naturalis historia* (77 C.E.; *Natural History*, 1938-1963), the Roman writer Pliny the Elder (23-79 C.E.) recounts their hostile behavior during the military conquest by Lucius Cornelius Balbus the Minor in 19 B.C.E. In *Ab excessu divi Augusti* (c. 116 C.E., also known as *Annales*; *Annals*, 1598), the Roman historian Tacitus (c. 56-c. 120 C.E.) recalls how the Garamantes raided cities on Libya's Mediterranean coast.

Knowledge of the Garamantian way of life has grown slowly during the modern era. The Italian archaeologist Giacomo Caputo excavated in the Fezzan during 1930's. His work led to the discovery of sixty thousand tombs. Another archaeologist, Mohammed S. Ayoub, excavated the area around Germa from 1962 to 1966. He uncovered cemeteries and what he believed to be the foundations of a royal palace. From the late 1960's through the 1970's, Charles Daniels excavated around the oasis of Wadi el-Agial, one of three oases in the Fezzan. His work revealed more burial grounds as well as irrigation systems. Daniels's work suggests that humans had been making use of the oasis for at least the past twelve thousand years.

Archaeological work continues at sites such as Germa, the hilltop fortress of Zinchara, the oasis of Saniat Gebril, and the burial ground of Saniat Ben Howedi. Germa was the capital of the Garamantes and has been called a metropolis by ancient Roman writers. It is believed that Germa started out as a settlement of mud-brick buildings in or before the fourth century B.C.E. Stone buildings date from around the first or second century C.E. During this time, trade between the Garamantes and the Mediterranean region was at its height. The Garamantes had turned from making war on their neighbors and the Roman occupiers of Libya into an important trading partner with

C. 500 B.C.E.-C. 200 C.E.

the Rome. Goods traded by the Garamantes included salt, gold, ivory, and slaves.

Taking off where Daniels's work ended, present-day archaeologists believe that the Garamantes tapped into desert groundwater (deposited when the Sahara experienced plentiful rain) and transported it via canals to their oases. In one oasis, Wadi al-Agial, the inhabitants were able to irrigate approximately three hundred square miles (777 square kilometers) of soil.

The Garamantes were at the mercy of their changing environment and adapted accordingly. When groundwater levels fell below the underground canal system, the Garamantes drove hundreds of wells into the Sahara to tap the lowered water level. They must have been successful in harnessing their diminishing water supplies because the Garamantes were able to support a state with a population of fifty thousand at the height of their power in the second and third centuries C.E. As the Sahara became increasingly dry, however, the Garamantes' civilization declined. By the sixth century C.E., it had all but disappeared. Small settlements continued to survive, clustered around oases fed by wells.

SIGNIFICANCE

The Garamantes succeeded in harnessing the water beneath the Sahara through a system of underground canals which allowed them to irrigate oases, where they carried on farming. They may have learned the technique of building these *foggara* from other ancient peoples such as the Egyptians. The Garamantes thus made use of the scarce resources of their dry environment to build a thriving civilization. The key factors of their civilization were the *foggara*, oasis settlements, a capital noted for its size and building type, and numerous burial mounds.

Adriane Ruggiero

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■ C. 500 B.C.E.-C. 300 C.E.

AGRICULTURE NURTURES KINGDOMS AROUND AFRICA'S NIGER RIVER

Kingdoms developed around the Middle Niger River in Africa, becoming socially stratified and increasingly complex.

LOCALE: Middle Niger River, Africa

AGRICULTURAL ISSUES: Archaeological discoveries

SUMMARY OF EVENT

The Niger River has its source in present-day Guinea and meanders through Mali, Niger, Benin, and Nigeria. It is the third largest river in Africa, rising within 150 miles (240 kilometers) of the sea in the Fouta Jallon highlands on the borders of Sierra Leone and Guinea. It extends for 2,600 miles (4,180 kilometers), and its basin covers an area of approximately 580,000 square miles (1.5 million square kilometers), including the lake region between Sansanding and Kabara. The Benue River, a tributary of the Niger, has its source in the Cameroon highlands.

Artificial earth mounds, reflecting either settlement sites or graves (*tumuli*), are found in the three main areas of the Middle Niger region: the Niger-Bani confluence in the Bani valley, north and northeast of Masina and Segou, and the area to the extreme east of the bend of the Niger River, in present-day Burkina Faso. According to African archaeologist Bassey Wai Andah, thick-walled wares served as burial pots in all three areas. In Burkina Faso (Niger Rim), researchers found iron or polished-and-ground stone tools as well as domestic pottery. Bronze and copper implements were found in the Niger bend area. At Masina and Segou, fine dishes and bowls with thin walls, footed cups, jugs, and conical jars were found. The people were generally farmers of the Iron Age, cultivating millet and rice, and others were fisherfolk who used nets with terra-cotta weights as opposed to bone harpoons.

Archaeological evidence found in what was known as the Western Sudan and is now Nigeria and Mali suggests that desiccation and the



Traditional Dogon house in Mali next to which stands a sturdy clay structure used to store grain. (©Wessel Cirkel/Dreamstime.com)

constant growth of the Sahara Desert precipitated the movement of pastoralists and agricultural producers southward and from the north and northeast between 5000 and 2000 B.C.E. There is some basis to suggest that certain species of rice such as the *Oryza Barthii* A. Chev (hardy rice) and *Oryza breviligulata* A. Chev and *Oryza Roer* may have been originally planted in West Africa in the middle Niger River region and that the delta of the Middle Niger was the point for varietal diversification of the rice species. Certain distinctive characteristics of the rice species such as the deciduous spikelets, the anthocyanin pigmentation of the flowers, the purple seed coats and the “floating” form, indicate a center of primary variation.

Oral traditions in West Africa, particularly in Northern Nigeria, from Wukari on the Benue tributary to Busa on the Niger, describe the Kisra Legend, which speaks about a royal ruler named Kisra from the east who migrated and forged numerous kingdoms. Remnants of

this anecdote are also found in Songhai. *Kisra* has been associated with the Hausa words *Sarki* or *Seraki* and the Busa word *ki-shira*. Traditions of eastern roots of ancient migrants to the Western Sudan are especially strong in Nupe and Borgu.

Archaeological sites such as Taruga and, to some extent, Bonga, Amo, Gurun, and Mongon in the Nok Valley in central Nigeria demonstrate the use of furnaces, indicating that ironworking was prominent and paved the way for the use of iron agricultural implements such as hoes and cutlasses, which revolutionized earlier agricultural practices. Findings of large beads of quartz, pottery, and bangles point to a thriving and increasingly sophisticated lifestyle of people in the Nok Valley. Just as the proximity of the Nile led to the emergence of the earliest civilizations around the Nile River Valley, so, too, the communities that lived close to the Niger River in West Africa experienced radical changes in the evolution of their lifestyles and cultures.

Iron use changed the kinds of weapons and tools used by the people around the wooded Niger Valley in the middle of the first millennium B.C.E. Removal of trees for human cultivation in forested areas through fires and bark peeling was probably considered a time-consuming and energy-intensive process. Africans in the Middle Niger River Valley may thus have become more receptive toward developing a more energy-efficient technology to meet increased subsistence needs. Iron use provided an important avenue to relieve physical stress and harness resources of the material environment for better living in a more effective manner. Iron-ended hoes and axes replaced those made of wood or stone.

Another important factor was the sedentary lifestyle of the communities in the middle Niger River Valley. The archaeological evidence suggests that these communities engaged in iron production periodically and not perennially. Further, the task of iron smelting was left to the specialist blacksmiths and master smelters, using the wood and ore available in the forested regions of West Africa. It is also probable that gold and silver mining occurred in parts of West Africa at close proximity to the Middle Niger region from the beginning of the first century C.E., even though excavations at Jenne-Jeno later unearthed a gold earring from 800 C.E. Jenne-Jeno became a fully settled center starting in 300 C.E. What is evident is that technological

skills were expanding in West Africa with the inception of the Iron Age.

As populations increased and social organization became more complex, the peoples of the middle Niger River Valley took to forming larger political structures that resembled states or institutions of governance and social maintenance. Trade began to expand, and with trade came enhanced economic prosperity, which beckoned people to organize themselves. Some became kings or community leaders and others the ruled or subjects. In other communities of West Africa, people collectively organized themselves into clans and familial units with no centralized authority, except a council of elders, as is the case in many African societies during the twenty-first century. The net result of these evolutionary changes—the beginning of earnest trade and commerce, the emergence of marketing relations, and the formations of towns and villages—was the sparking of greater social differences and the exacerbation of social stratification among different segments of communities in the Middle Niger River Valley.

Graham Konnah, a Euro-Australian archaeologist, notes that the *tumuli* point to a formalizing of power by African leaders, derived from their control of iron and later gold deposits that led to further social stratification. It was this process of accumulation of wealth from mining and agricultural expansion that preceded the emergence of the vast Ghana Kingdom in the eighth century C.E. and the successive urban centers of the first millennium C.E.

SIGNIFICANCE

What is clear in the chronology of events from 500 B.C.E. to 300 C.E. in the Middle Niger River region is that African civilizations were evolving as numerous other civilizations were in Asia, the Americas, and Europe. West Africa skipped the Bronze Age, showing that there is no law of historical evolution that demands a region go through such a stage of cultural and technological development. The view that Africans were undeveloped and West Africa was a land devoid of civilizations before European colonialism is shattered by the preponderant archaeological evidence demonstrating some of the most sophisticated civilizations of the era, equaling or exceeding cultures in other parts of the world. The Middle Niger River region's cultures, from

the first millennium B.C.E. through the first millennium C.E., reflect consistent technological innovation and social complexities that paved the way for the towering civilizations in Ghana, Mali, and Songhai that would last through the fifteenth century.

Julian E. Kunnie

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SEE ALSO: c. 10th millennium B.C.E.-10th century C.E.: Agriculture and Animal Husbandry; c. 6500-c. 5000 B.C.E.: Nilo-Saharan Farmers Spread Cultivation and Herding; c. 6000-c. 1000 B.C.E.: Omotic Peoples Advance Farming Techniques in Africa's Horn; c. 5500-c. 4500 B.C.E.: Niger-Congo Peoples Spread Agriculture in Africa; c. 1000 B.C.E.-c. 300 C.E.: Trade Fosters Agriculture in West Africa's Sudan Belt; c. 500 B.C.E.-c. 300 C.E.: Agriculture Nurtures Kingdoms Around Africa's Niger; c. 400 B.C.E.-c. 300 C.E.: Bantu Peoples Spread Farming Across Southern Africa.

■ C. 400 B.C.E.-C. 300 C.E.

BANTU PEOPLES SPREAD FARMING ACROSS SOUTHERN AFRICA

The movement of the Kusi Bantu across the eastern and southern parts of Africa spread a variety of agricultural practices, as well as the Bantu languages.

LOCALE: Southern and southern central Africa (present-day Angola, Zambia, Mozambique, Zimbabwe, and South Africa)

AGRICULTURAL ISSUES: Cattle keeping; Hunting and gathering; Migration; Subsistence agriculture; Tropical produce

SUMMARY OF EVENT

Between 400 B.C.E. and 300 C.E., a process of population relocation was under way in southern and south-central Africa, initiated by Bantu communities. This population movement and resettlement was a continuation of the expansion of Bantu communities within eastern Africa beginning around 1000 B.C.E. Several factors contributed to these demographic shifts among the Bantu-speaking communities, in both eastern and Southern Africa. The most significant and ecologically visible dynamic spurring migration was a prolonged population growth. Large demographic increases for an extended period of time over several centuries likely threatened the stability of the food supply in the western parts of East Africa, ultimately leading to the expansion of Bantu populations out of eastern Africa and into Southern Africa.

Speakers of non-Bantu languages with hunting-and-gathering economies were the primary inhabitants of Southern Africa until the latter part of the last millennium B.C.E., when the Bantu agriculturalists began to emerge. The primary inhabitants of Southern Africa before the Bantu arrival spoke ancestral Khoikhoi languages, which are related to the few remaining Khoisan languages of modern-day Southern Africa. In contrast to the strictly hunting-and-gathering lifestyle of the semidesert-dwelling populations of Southern Africa, the earliest Bantu had combined hunting and gathering with root-crop agriculture in the tropical forests of western and central Africa,

and their descendants continued this system of food production with some modifications.

By the last millennium B.C.E., the Bantu agriculturalists of western Africa were, like their later eastern African counterparts, faced with growing populations requiring intensified production. The intensification of cultivation in western and eastern Africa resulted in a need for more land on which to grow crops; however, the same land was also in progressively greater demand for settlement by the increasing populations. The food supply was steadily enhanced in quantity and variety, but intensification of cultivation meant there was greater pressure on the land as a resource. The option chosen by some segments of the Bantu in eastern Africa was to relocate away from the western side of East Africa. Thus, a population expansion and migration into far eastern and Southern Africa was well under way by the fifth century B.C.E. Settlement was expanded through many parts of the forest and to the edges of woodland savannas to the south and east.

In the east, the non-Bantu Sahelians, who were already well established, introduced to the Bantu speakers both grain cultivation and the domestication of animals such as sheep and cattle. The spread of Bantu populations into Southern Africa was greatly facilitated by the introduction of grain crops. Unlike root crops, which require relatively high rainfall levels or irrigation for each plant, grains such as sorghum and certain millets grow well in dry environments. The southern and eastern parts of Africa, which were too dry for traditional forest crops, were perfectly suitable for grains. Thus the Bantu incorporated new economic practices from eastern Sahelian grain cultivators and turned again to migration as a means of alleviating population pressures and resource competition within the western Great Lakes region of East Africa. In some areas of eastern Africa, the eastern Sahelian speakers and Bantu had extensive social contact; in the case of the central Sudanic and Sog peoples, many began to be assimilated into Bantu-speaking communities.

The most commonly followed routes of migration must have been through the generally tsetse-free corridors of East Africa, which extend south and southeast of modern-day Tanzania from the Rungwe Mountains along the western side of the Lwangwa River Valley to the Batoka Plateau of southern Zambia. The Mashariki Bantu spread far-

ther east and into the south across East Africa into the regions known during the early twenty-first century as Uganda, Kenya, and Tanzania. Other Bantu peoples, known to scholars as Kusi Bantu, spread directly south from the savanna into areas of what is now the southern Congo Democratic Republic and into modern Angola, Zambia, Mozambique, Zimbabwe, and South Africa. In the southern regions, the Kusi Bantu encountered Khoisan-speaking peoples who engaged predominantly in hunting-and-gathering economies.

A complex of crops allowed for settlement in a greater variety of regions, and the increase in both quality and quantity of food production continued the trend of Bantu population growth. The smelting of iron allowed production of tools such as axes, hoes, arrows, spears, and knives, which, scholars conclude, facilitated movement into a diversity of environments in which new communities could be pioneered. The introduction of luxury goods, as well as new apparatuses and technologies of food production, made trade with neighboring communities attractive. New tools made from iron alleviated the difficulties of acquiring the heavily demanded firewood for cooking, pottery making, and ultimately more iron smelting. Iron production allowed for the making of equipment and tools more durable than their stone or wooden counterparts. In the dry regions of eastern and Southern Africa, where grain was typically grown, there were not many forested areas to be continuously cut down for wooden tool production. Iron could be smelted in forested areas at local smelting sites, and then the iron that was produced could be carried back to the more distant settlements in savanna and nonforested areas.

SIGNIFICANCE

The spread of Bantu populations over most of southern and eastern Africa spread Bantu languages through eastern and Southern Africa, which has had a tremendous impact on the linguistic landscape even into present times. Over centuries, Bantu-speaking communities seem to have absorbed speakers of Khoikhoi languages and reduced the number of descendant Khoisan-speaking communities. In the twenty-first century, more than one-third of the African continent speaks Bantu languages because of the large area over which the Bantu spread, although in most previously Khoikhoi-speaking regions there are some Khoisan root words and linguistic features, such

as clicks, which have been preserved through incorporation into the Bantu languages.

The concept of grain cultivation moved with the Bantu into areas that were once habitable only by hunters and gatherers because few known indigenous plants could be domesticated and cultivated as staple crops in these areas of Southern Africa. The Bantu can be credited with introducing cultivated grains and cattle raising, two new subsistence practices, to a variety of areas within Africa, particularly in the arid south and east. Because domestic animals reproduce more rapidly and frequently than humans, cattle raising, along with grain production, created a secure supply of foodstuffs. With increased agriculture in Southern Africa came the opportunity for villages and town centers to develop, as people were typically drawn to the new agricultural areas. Before the arrival of Bantu agriculturalists, the population density of the indigenous Khoisan across Southern Africa was low. The expansion of the Bantu therefore was characteristically rapid, because there was a very modest population to deter Bantu establishment of settlements in many areas.

The use of iron was expanded into new regions as the cultivation of grain was spread with Bantu population movement. This disper-



Early Bantu migrations helped to spread cattle keeping throughout central and southern Africa. In many societies, cattle were prized more for their value as status symbols than for their economic value, and features such as large horns added greatly to their value. (Library of Congress)

C. 400 B.C.E.-C. 300 C.E.

sion of technology led to increased modifications of iron smelting and smithing within Southern Africa. Social and economic changes emerged as different groups of people spread and lost their connections to other Bantu communities from which they had diverged geographically and culturally. Some of the cultural changes included a shift from a double-descent system (wherein matrilineage, matrilineage, and patrilineage were significant) to a system wherein such bilateral lineage connections became irrelevant. In Southern Africa, either matrilineages were central or, in a few select locations, patrilineages became the principal unit of social organization. In some areas of Southern Africa, the distribution of iron wealth gave rise to communities in which clan became more important than lineage in social precedence.

Katherine B. Beem

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■ C. 300 B.C.E.

HOHOKAM IRRIGATION SUPPORTS AGRICULTURE IN AMERICAN SOUTHWEST

Adapting to their harsh desert environment, the Hohokam people—who were the ancestors of the modern Pima and Tohono O’Oodham—established thriving agricultural settlements made possible by large-scale irrigation systems.

LOCALE: Southern Arizona

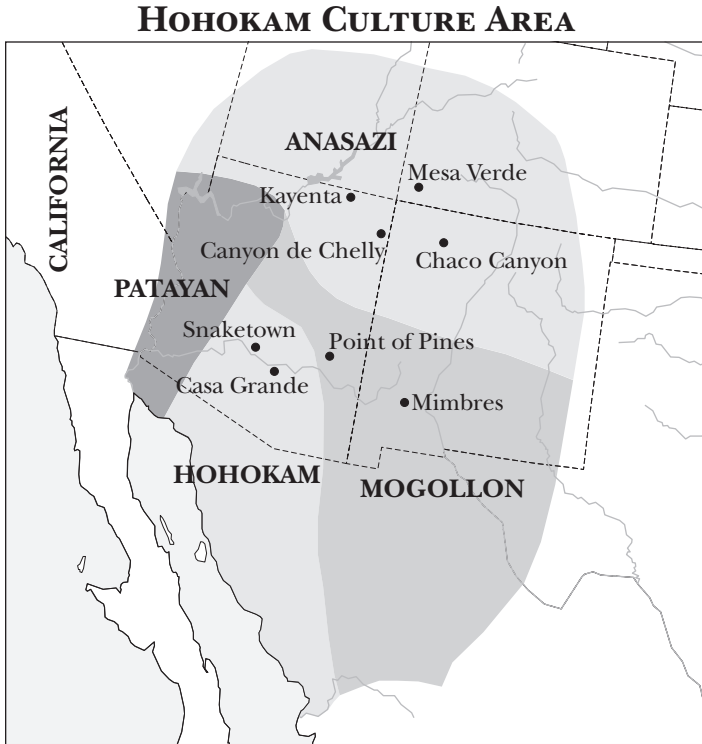
AGRICULTURAL ISSUES: Archaeological discoveries; Hunting and gathering; Irrigation and water management; Native American agriculture; New crops and food products; Subsistence agriculture; Textile industries

SUMMARY OF EVENT

One of four major prehistoric cultures in the American Southwest, the Hohokam people, ancestors of the modern Pima and Tohono O’Oodham, lived in the fertile valleys of the Salt and Gila rivers in what is now southern Arizona. Artifacts show that this seemingly bleak region, the Arizona-Sonora Desert, was home to the Hohokam for more than seventeen hundred years, but archaeologists are not certain where the Hohokam originated. It is unknown whether they were descendants of the earlier Cochise people, who hunted and gathered in the same desert area, or if they migrated from Mexico. Much of their cultural history suggests a Mesoamerican influence; however, this could have been acquired through the extensive trade routes established by the Hohokam.

Development of Hohokam culture occurred in four phases: Pioneer, 300 B.C.E.-500 C.E.; Colonial, 500-900 C.E.; Sedentary, 900-1100 C.E.; and Classic, 1100-1400 C.E. The Hohokam culture was similar to the desert cultures of the Anasazi, Hakataya, and Mogollon, but a major difference was their complex irrigation system. Evidence from the Pioneer phase shows that the Hohokam lived in pit houses and began the cultivation of corn in their small villages. Floodplains along the rivers were rich with silt deposited from spring rains and snowmelt

C. 300 B.C.E.



from nearby mountains. The earliest irrigation was probably achieved by directing the floodwaters.

About 300 B.C.E., during the Pioneer phase, the village of Skoaquick, or Snaketown, was founded on the north bank of the Gila River. The first canal was built there to divert river water to irrigate fields as far as three miles (five kilometers) away. Early canals were shallow but very wide. Later, using technology from Mexico, the Hohokam built narrow, deep canals with many branches and lined them with clay to channel water more than thirty miles (forty-eight kilometers). Gates made of woven grass mats controlled the flow from large dams throughout the canal system. Archaeological evidence suggests that construction of the canals was done by men using digging sticks and stone hoes. Earth was carried away in baskets by women and was probably used in building their pyramid ceremonial platforms.

Continual maintenance was needed to keep the canals open after

floods or thunderstorms, but this full-time technology provided a reliable subsistence for the Hohokam and supported a denser population. Instead of harvesting crops from the natural habitat, the Hohokam successfully brought agriculture into their villages to develop a stable farming society in which the men tended the fields instead of hunting.

As domesticated corn moved northward from Mexico, it evolved into a new type with a floury kernel more easily crushed when dry. The Hohokam harvested their domestic corn and prepared it by traditional desert-culture methods of sun-drying, parching in baskets with coals, and grinding dried kernels. Storage in large pits kept their surplus food secure for several years. The plentiful food supply allowed time for the creation of art, including shell carving, loom weaving, and pottery making. Images of Kokopelli, the humpbacked flute player, a fertility god believed to assure a good harvest, frequently decorated the pottery. Epic poems carried Hohokam cultural history through many generations.

The archaeological record shows that the Hohokam had no weapons; their bows, arrows, and spears were used for hunting deer, rabbits, and other small game to supplement their crops. Deerskins and rabbit fur were used for ponchos, robes, and blankets. Cotton shirts and breechcloths were typical outfits for men, and apron-skirts of shredded fiber were worn by women. Both wore sandals of woven fiber and wickerwork. Other Hohokam artifacts include stone and clay pipes, cane cigarettes, noseplugs, wooden spoons, flutes, and prayer sticks. Stick and ring games, guessing games, gambling bones, and dice were also part of Hohokam culture.

SIGNIFICANCE

Later remains tell the story of how the Hohokam evolved after the ancient Pioneer phase. In addition to pottery and domestic crops, which by 600 C.E. included cotton, the Colonial phase shows the use of astronomy to calculate planting dates. Narrower, deeper canals were dug to control evaporation, ball courts were built for ceremonial use, and images of the feathered serpent were used in ceremonial art.

In the Sedentary phase, a smaller area of the desert was occupied by the Hohokam. Greater development occurred in the material cul-

ture, which showed more influence from Mexico: red-on-buff pottery, copper bells, turquoise mosaics, iron-pyrite mirrors, textiles, and bright-feathered macaws as pets in homes. During this period, Hohokam artists began the process of etching. The earliest people in the Western world to master the craft, they devised a method of covering the shells with pitch, carving the design, then dipping shells in the acidic juice of the saguaro cactus fruit. Along with salt, these shells were highly prized for exchange on the extensive trade route.

During the Classic phase, the Salados (a branch of the Anasazi people) moved into Hohokam territory, bringing a new architecture of multistory adobe houses. They introduced other varieties of corn, as well as beans and squash, and brought basketry, the newest art form. Always peaceful people, the Hohokam coexisted with the Salados, who assisted with the building of canals. By 1350 C.E., the complex network extended more than 150 miles (240 kilometers). Of great importance to the Hohokam were the new songs and ceremonies brought by the Salado, for these kept the world in balance and assured a life of abundance and harmony.

Snaketown, after its start as the year-round site of a village of about fifty families who relied on the production of domestic crops, remained the center of Hohokam culture for fifteen hundred years. During the expansive period, more than one hundred pit houses covered the 300-acre (120-hectare) site. A highly developed social organization was needed to oversee the large population, produce abundant food, and maintain the network of canals. As their culture evolved through the Classic phase, Hohokam social organization shifted from small bands to tribes to chiefdoms to states.

During the early fifteenth century, the Hohokam abandoned Snaketown and other settlements, possibly because of a long period of drought. In the nineteenth century, Mormon farmers used part of the network of canals skillfully engineered almost two thousand years earlier. Continuing the legacy, a canal at Snaketown near present-day Phoenix was reconstructed in the twentieth century to divert water from the Salt River.

The ancient Hohokam spoke Uto-Aztecan, one of the seven Southwest language families, which also included Hopi, Pima, Yaqui-Mayo, and Huichol. In the Piman language, the term “Hohokam” translates as “the vanished ones.” Myths and songs about the mysteri-

ous desert whirlwinds are found in Piman culture, inherited from their Hohokam ancestors. Although the Hohokam are gone, much of their culture and some of their developments remain as their legacy.

Gale M. Thompson

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States. Rev. ed. Chicago: University of Chicago Press, 1971. Concise volume surveying origins, history, and definitive accounts of social customs, material culture, religion, and mythology. Written from the perspective of the first peoples of North America. Illustrations, maps, notes, extensive bibliography, and index.

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■ C. 300 B.C.E.

JAPAN DEVELOPS SETTLED AGRICULTURE DURING YAYOI PERIOD

The Yayoi period marks the transition from hunting-and-gathering societies in Japan to those with a settled agricultural lifestyle, coinciding with the introduction of bronze and iron.

LOCALE: Kyūshū, Japan

AGRICULTURAL ISSUES: Hunting and gathering; Irrigation and water management; Marketing and trade; Population growth

SUMMARY OF EVENT

The Yayoi period is the second major prehistoric age in Japan. The name derives from Yayoi-chō, a section of the University of Tokyo campus where the first pottery unique to the period was discovered in 1884. The Yayoi is traditionally dated from 300 B.C.E. to 300 C.E., and was preceded by the Jōmon period (c. 10,000-c. 300 B.C.E.), which was marked by a hunting-and-gathering style of life. During the Yayoi, bronze and iron usage appeared for the first time, wet-rice cultivation was introduced, the population increased dramatically, and social and political organization began to emerge.

The period is broken up into three divisions. The Early Yayoi (c. 300-100 B.C.E.), centered in northern Kyūshū, represented a transitional phase during which the population adopted a mixed economy of rice cultivation and hunting and gathering. Evidence indicates that shellfish, a staple of the Jōmon diet, was still an important source of protein. Simple political divisions began to emerge at this time, with the settlements, most located in low, marshy areas, being ruled by a variety of chieftains.

The Middle Yayoi (c. 100 B.C.E.-100 C.E.) witnessed the development of water control systems for irrigation, the movement of settlements onto higher ground purposefully cleared, and the use of a variety of new tools, including many tipped with or made entirely of iron. Evidence indicates that the culture had spread as far north as present-day Nara.

*Late nineteenth century
Japanese drawing of a
traditional farmer working
with a large wooden spade.*
(Library of Congress)



During the Late Yayoi (c. 100-300 C.E.), irrigated wet-rice cultivation was perfected, complex political units began to emerge, and the culture extended to the northernmost reaches of Honshū. As Hokkaidō is too cold for growing rice, Yayoi culture never affected the far north of the Japanese archipelago.

The two most important advances of the Yayoi period are the introduction of wet-rice cultivation and the simultaneous entrance into the Bronze and Iron Ages. It is most likely that wet-rice technology was introduced into northern Kyūshū from the late Bronze Age culture in Korea. Trade was widespread, and evidence of significant contact between the Koreans and Jōmon Japanese is abundant. As noted above, the initial stages of settlement centered on low, marshy regions, where the inhabitants could take advantage of the natural irrigation, flooding, and accessible water tables. Diked fields and drainage systems allowed for ideal conditions to grow rice. Cultivation at this stage was simplistic, with hoes, spades, and reaping knives made of wood and stone. In the transitional stage, the basic diet was supplemented by hunting, gathering, and fishing. Even at an early period, however, communities were beginning to form around the new agricultural centers, with one of the oldest sites, in Itazuke, Fukuoka, boasting at least thirty homes.

As technology advanced in the Middle Yayoi, elaborate irrigation systems were developed and iron-tipped tools introduced. Paddy cultivation became a large-scale enterprise in some communities. Excavations at Toro, in present-day Shizuoka, reveal the technology and lifestyle of a Middle Yayoi community, which had a highly developed rice cultivation system, with more than fifty paddies covering seventeen acres. Supplied by sluice-gated irrigation ditches, the paddies sloped south, with residences and a storehouse located to the north. The paddies were separated by carefully cut wooden slats, presumably cut with iron tools. As production rose, storehouses were constructed with uniform planks for the flooring and walls, and the whole structure was raised three to six feet (one to two meters) above ground, with wooden collars on each of the six posts to keep rodents out.

The homes, referred to as pit houses, were typically built with semi-subterranean floors, generally 1.7 feet (0.6 meter) below the surface. The pits were oval, with a cone-shaped superstructure built of poles and topped with a thatched roof of reeds or bark. The single-room dwellings typically had a central fireplace, with the interior banked with earth, creating a bench that supported wooden planks. The average home measured nineteen by twenty-six feet (three by eight meters). Inhabitants wove cloth from flax and paper-mulberry fibers, and evidence suggests that men wrapped lengths of cloth around their bodies, while women slit a single piece and slipped it over their heads. Jewelry was manufactured, with jasper and jade beads strung together into necklaces and bracelets and occasionally made into rings.

The early Yayoi depended on a variety of wooden and stone tools. Typical implements included wooden rakes and shovels, fire drills, looms, and lathed bowls and cups. Some furniture was produced, and rice paddy clogs, known as *geta*, were used when transplanting rice. Stone tools became increasingly sophisticated, the axes and adzes growing larger and more highly polished, and were increasingly used for reaping rice, chopping, and tilling.

By the middle and late periods, iron and bronze had entered Japan. As was so often the case, bronze was primarily used by the upper class, both as a status symbol and for weapons, while the lower classes used iron to fashion tools and weapons. Bronze ar-

rowheads may have been introduced as early as the second century B.C.E., with other weapons such as halberds, daggers, and short swords appearing in Kyūshū by the first century B.C.E. Local production in sandstone molds began in northern Kyūshū and around the Inland Sea, although quality was uneven for at least a century. As a symbol of wealth and power, the majority of bronze manufactures were mirrors, bracelets, coins, vessels, shield ornaments, and bells. A large number of bells have been uncovered, and it appears as though the Kinki region may have dominated this particular market. Bells throughout Japan were manufactured from the same mold and identified with the Kinki region. The majority appear to be ritualistic in nature; a number of sites have been uncovered in which several bells are buried in hillside terraces overlooking fertile fields. The reasons behind the burials are still shrouded in mystery, but many scholars speculate that they served in some type of ritual to ensure a good harvest.

At the same time, small-scale iron smelting produced a variety of implements and weapons. By the late Yayoi, iron was being used to fashion farming implements such as plows, sickles, and hoes; iron axes, chisels, and planes allowed for more sophisticated woodworking; and arrowheads, swords, and halberds, along with spearheads and fishhooks, were also forged. As noted, these tools allowed the inhabitants to move out of the marshy lowlands to comparatively dry land, where the soil was better suited to rice cultivation. The ability to clear forests and construct elaborate paddy field systems paved the way for very labor-intensive rice cultivation, which in turn produced larger and larger harvests. Because rice has more calories per unit than other farm products produced at the time, it was able to support a much greater population. Although exact numbers are unknown, some speculate that the population grew from an estimated 250,000 in Jōmon to 600,000 in the Middle Yayoi, and perhaps as many as 2.5 million by 300 C.E.

The growing population and emergence of agricultural villages naturally led to the development of social and political organizations. According to the *Wei Zhi* (written between 280 and 297 C.E.; “The History of the Wei Kingdom,” 1951), a Chinese history that provides the best glimpse of Yayoi society, Japan had become a highly stratified society by the third century C.E., with wealthy landowners ruling com-

moners. It also refers to yamatai, a kingdom ruled by the shamaness Queen Himiko, that controlled more than thirty countries (*kuni*), each with their own chieftain. Within this kingdom, taxes were collected, marketplaces served as centers of trade, and class distinctions were rigidly enforced. When passing a member of the upper class on the road, commoners were required to retire to the roadside and kneel to show their respect. Although commoners had only one wife, the nobility were allowed four or five.

SIGNIFICANCE

The Yayoi period marks a watershed in Japanese history. The Japanese transitioned from hunting and gathering to settled agricultural communities with highly structured and complex social organization and began to establish the foundations for the political, economic, and military specialization that would follow in the Kofun period (c. 300-710 C.E.).

The origins of Yayoi culture remain under study. Older theories proposing massive immigration from mainland China that overwhelmed and replaced the Jōmon have largely been abandoned. Consensus now holds that some immigration certainly took place during this period. Refugees and traders from Manchuria and Korea, along with immigrants from the Yangtze River region, undoubtedly brought the already developed technology of iron smelting and wet-rice cultivation. However, there is no evidence to suggest a wholesale replacement of the indigenous population with mainland immigrants.

The most likely scenario involves a degree of intermarriage between the Jōmon and immigrants, especially in western Japan, where the Yayoi are on average taller. In eastern Japan, the Jōmon simply adopted the new cultural elements. For example, the use of storage pits was developed in north China as early as 4000 B.C.E., and it is clear that the Yayoi imitated the production of such items as bronze mirrors and weapons, iron tools and weapons, and the building of wooden houses on posts, prominent in south China. Once adopted, however, these techniques and technology helped turn the Japanese archipelago into a flourishing and complex society.

Jeffrey W. Dippmann

C. 300 B.C.E.

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■ C. 300 B.C.E.-C. 100 C.E.

SOUTHERN AFRICA'S KHOIKHOI AND KWADI ADOPT PASTORALISM

Deviating from the San hunter-gatherers of Southern Africa, the Khoikhoi and Kwadi peoples realized the economic potential of pastoralism and began herding sheep and cattle.

LOCALE: Southern Africa (present-day South Africa and Namibia)

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Hunting and gathering

SUMMARY OF EVENT

Khoisan (Khwe) herders entered Southern Africa in approximately 300 B.C.E., replacing the hunter-gatherer San peoples who had inhabited the area since the early first millennium B.C.E. Given the nature of the communities known as Khoisan (the name that denotes this group as one of both herders and hunter-gatherers), it is difficult to pinpoint either their exact date of arrival in the region or their specific place of origin. This is important to note because experts have repeatedly issued the caveat that too closely defining the boundaries of hunter-gathering and herding societies would be counterproductive in the effort to uncover their pasts. As there were no livestock known to have originated in Southern Africa, a fundamental question is how the Khwe people and their herds came to the region. Historians traditionally believed that modern Khoisan pastoralists, namely the Khoikhoi of South Africa and the Kwadi people of Namibia, originated in northeastern Africa and traveled southward until reaching the Cape. In recent times, however, expert opinion has swung to the hypothesis that the herding people of Southern Africa came from the eastern Sahelian region, in present-day Botswana and Zambia.

During the third and fourth centuries B.C.E., when the Khoisan herders came to inhabit regions previously occupied by hunter-gatherer groups, these newcomers brought with them much more than livestock. The introduction of domestic animals to Southern Af-

rica had a significant impact on life in the region. For example, while the hunter-gatherers were able to sustain themselves on very little land, the pastoralists required vast amounts of terrain to graze their livestock; weather and the seasons dictated the migration of the Khoisan herders. The pastoralists spent the summer months near the coast and then traveled inland to allow their livestock to graze on the fertile grasslands along the mountain rivers. These societies even transplanted their more permanent homes from season to season by placing them on the backs of their oxen and traveling between the inland settlements and the coast. This practice was very different from that of the hunter-gatherer societies that lived in small clans and could stay in one place for a relatively long period of time.

Despite the need for seasonal migration, herding livestock was very successful economically. True entrepreneurs, the Khoikhoi and the Kwadi realized the advantages of combining herding with hunting and gathering, and as a result their populations grew nearly four times as large as those of the earlier inhabitants. Because of their versatility and success in the region, the Khoisan were able to spread into Namibia and into South Africa as far as the Cape. Instead of small, family-sized clans, the Khoisan settled in larger patrilineal societies; these larger communal societies were able to split and spread, leaving many groups of related community members around the region. Also, unlike purely hunter-gatherer societies that often experienced the hardships of drought and lack of game, the Khoisan peoples were able to supplement their diets with milk and the meat from their livestock when necessary. As scholar Christopher Ehret explains in *The Civilizations of Africa* (2002):

Each cultural spread was as much of an economic frontier as of people. As often as not, the new economy would have advanced because the people ahead of the economic frontier saw the advantages of the new mixed hunting and herding adaptation, accepted it, and made it their own.

As Ehret suggests, when this frontier expanded, the Khoisan inevitably encountered the hunter-gatherer societies and in many cases welcomed newcomers into their clans; their interactions with the hunters were influential and resulted in intermixing rather than con-

frontation or hostility. Yet with this new economy came a new way of life for much of the region. Cattle became the livelihood of these societies, and the introduction of ownership and wealth changed the character of society. There was now a hierarchy that often placed hunters at the bottom of the social order and patriarchs with an abundance of cattle at the top. Also, the split-and-spread method of the herder clans led to a less cohesive community and to lineages that became more difficult to trace over time.

SIGNIFICANCE

Pastoralism, perhaps one of the most significant methods of livelihood in Southern Africa, has been a topic of contention and historical inquiry for centuries. Socially and economically, the herders of Southern Africa played a pivotal role in the growth and change of the region. History has recognized the Khoisan peoples' adoption of sheep and cattle herding not only as socially important but also as economically progressive. The level of sophistication and social effects that herding brought to Southern Africa through the Khoikhoi and Kwadi peoples is an important subject of study because it changed the way many inhabitants of the region came to structure their society. Social order, wealth, and acquisition became the economic drive of society.

In addition, pastoralism has survived nearly thirty centuries. To this day, cattle herding is a mainstay in many regions of Southern Africa, including the better part of South Africa as well as northern Namibia. The fact that pastoralism has been so successful and fundamental to the changing societies of Southern Africa has prompted years of historical research on the region. Unfortunately, a lack of archaeological evidence, combined with large migration and cultural mixing, have made study of the Kwadi (more so than study of the Khoikhoi of the southern Cape) arduous. Because the introduction and spread of pastoral peoples occurred in the prehistoric era of the region, historians have had to call on various means of research and have come to a number of contentious conclusions about the origins of these cultures.

Mellissa Jeanne Betts

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■ 221 B.C.E.-220 C.E.

CHINESE AGRICULTURAL TECHNOLOGY ADVANCES

The short-lived Qin Dynasty and the following four-hundred-year Han Dynasty brought significant technological advancements and government policies relating to agriculture that affected China for two thousand years.

LOCALE: China

AGRICULTURAL ISSUES: Agrarian reform; Archaeological discoveries; Fertilizers; Feudalistic systems; Innovations; Irrigation and water management; New crops and food products; Population growth

SUMMARY OF EVENT

The period preceding the Qin Dynasty (Ch'in; 221-206 B.C.E.) in China was called the Chan-kuo (Ch'an K'uo), or Warring States Period (475-221 B.C.E.). All Chan-kuo states used iron for implements and weapons and irrigated and fertilized crops. These iron implements were crude but vastly superior for clearing and tilling land than their stone and wooden predecessors. The largest irrigation systems were found in the state of Qin, but extensive irrigation projects were not widespread until the Qin Dynasty and Han Dynasty (206 B.C.E.-220 C.E.). During the Chan-kuo period, suitable crops were matched to the soil and seasons, and rice was grown only in the southern region, which had naturally flooded fields.

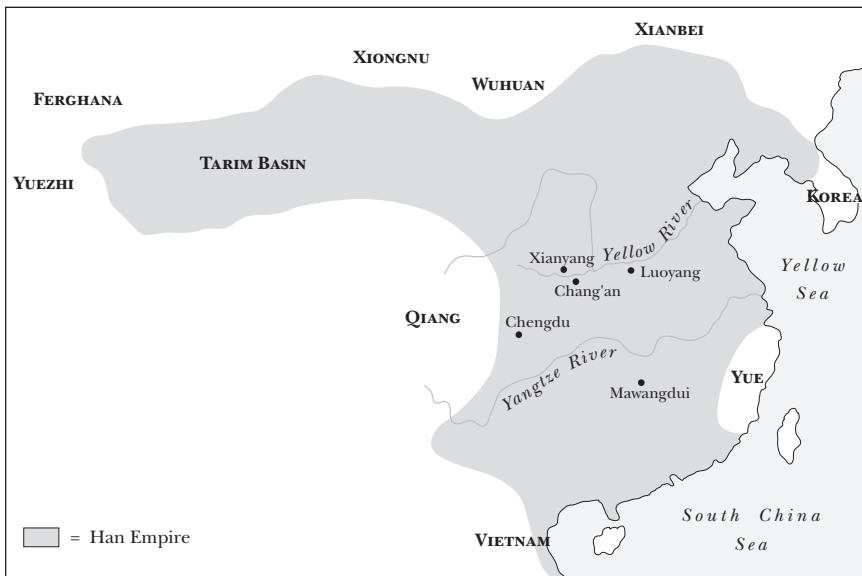
Social and political reforms instituted by the ruler of the state of Qin, under the guidance of his adviser, Shang Yang (d. c. 337 B.C.E.), proved to be powerful catalysts for its eventual supremacy, which ended the Warring States Period. Allowing the private ownership of land made small family farmers economically important and transformed a feudalistic society into a strong, centralized monarchy. Qin military power was enhanced by giving public lands to immigrants so that they could create small farms, which allowed citizen and immigrant farmers the time to enhance their social status through military service. In 221 B.C.E., Qin prevailed over the other Chan Kuo states

and established the Qin Dynasty, China's first unified empire. Shi Huangdi, the first emperor of the Qin Dynasty, extended the reforms of the state of Qin to the entire country. The effective strategy of using the productivity of free land-owning small farmers, who could advance economically and socially, to support the centralized imperial administration was adopted by the ensuing Han Dynasty and used for generations.

Liu Bang, a peasant warrior, defeated the Qin Dynasty in 206 B.C.E. and established the Han Dynasty, renaming himself Gaozu. This empire endured for more than four hundred years, interrupted briefly by the Xin (Hsin) Dynasty from 9 through 23 C.E. After seven disruptive years of civil war, the masses of dislocated citizens were encouraged to return to their areas of origin. The emperor proclaimed that their land and homes would be returned to them and that other citizens of merit would be given land and homes. Then the slow process of increasing agricultural productivity to prewar levels began.

The Han Dynasty was divided into the Western Han Dynasty (206 B.C.E.-23 C.E.) and the Eastern Han Dynasty (25-220 C.E.). The population at least doubled, and possibly quadrupled, during the Western

CHINA DURING THE HAN DYNASTY

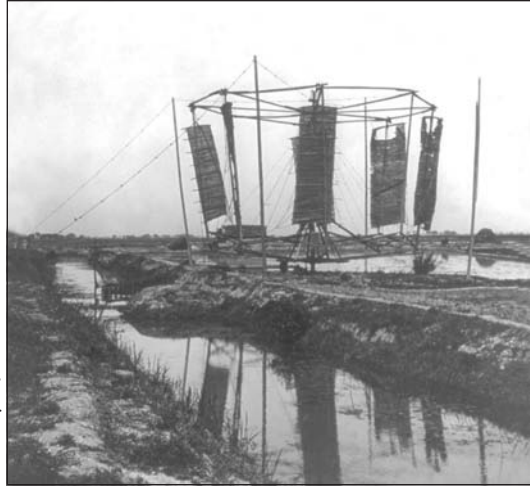


Han period. Early in this period, population growth-related pressures prompted influential citizens to petition the government to enact policy initiatives designed to increase agricultural productivity. These entreaties were mostly ignored by Han emperors for more than a hundred years. Farmers were moving to cities in large numbers to pursue more lucrative occupations, which had the effect of slowing the pace of agricultural improvements. When the government did force the relocation of masses of urban dwellers back to farms starting in 178 B.C.E., when land was still available in all parts of the empire, the people were moved to the northern and northwestern frontiers for defense purposes rather than to the south, where their farms would have been more productive. By 140 B.C.E., available arable land was scarce, and the government opened up public land to farmers, which bore positive results for some time, but by the end of the Western Han Dynasty, this land was exhausted.

Farming in the Han Dynasty was initially based on the Qin Dynasty model, which emphasized mostly small farms that used some irrigation and fertilization but more often matched crops to natural soil conditions and employed crudely made iron implements and relatively primitive methods of tilling and sowing fields with a limited number of crops. Throughout the two Han Dynasties, new crops were added, providing Han farmers with several cereals, including beans, rice, barley, oats, wheat, and millet; a number of vegetables; and cash crops such as hemp, indigo, sesame, mulberries, and gourds. These farms became increasingly well organized and productive as crop rotation and intensive agricultural techniques and implements were developed.

As the first century B.C.E. progressed, population growth in the capital district and the increasing demand for crops such as rice and wheat that required a great deal of water led to official policies that called for and publicly supported the creation of irrigation systems. Fifty-six water control projects for irrigation and land reclamation have been documented during the Han Dynasty. The largest were created by imperial proclamation and involved tens of thousands of laborers working for years. Smaller systems were built by local administrations and private investors. These systems spread throughout the country. Han irrigation projects utilized advanced engineering technology for dam building, complex networks of troughs and trenches

*Old-fashioned Chinese
windmill used to move water
for irrigating rice fields.
(Library of Congress)*



in fields, and siphons, water wheels, and other mechanical devices for raising water from lower to higher levels. Archaeological evidence indicates that eventually every Han household had a well with a sophisticated system for drawing water and a water tank with an opening into an irrigation ditch.

Two new dry-farming and one new wet-rice-farming technique contributed to much higher productivity for Han farmers. The *dai tian* (*tai-t'ien*) method of “ridge farming” involved plowing to produce trenches, or furrows, with the removed dirt piled beside them, creating ridges. Seeds were then planted in the furrows, and the dirt was gradually pushed back in as the plants grew. This technique was far more successful than sowing large amounts of seed on a flat field, because less seed was required, moisture was held in the furrows, and plants got more sun and were protected from the wind. The *ou zhong* (*ou chung*) method of “pit farming” involved digging small square pits on plots of land and growing well-irrigated and well-fertilized crops in them. This method made it possible to farm land that was marginal or too small for conventional plowing and reportedly resulted in dramatically increased yields. In the northern regions, improved crop yields were realized by growing rice seedlings in a nursery while other crops were grown and harvested, then planting the seedlings in the fields, which were flooded through irrigation, and harvesting the rice after a short growing season.

Available evidence indicates that most of the agricultural implements of the Western Han Dynasty were made of cast iron and were relatively small and fragile. By the Eastern Han Dynasty, apparently there had been a major breakthrough in iron technology, including the invention of the water-driven bellows, resulting in greatly improved high-grade wrought-iron implements during this period. Han plows came to be produced in many sizes and were made of materials and with new designs that made deeper plowing and the use of new farming methods such as *dai tian* practical. The government-owned iron foundries produced and distributed other high-quality implements, such as various configurations of sickles, spades, and hoes, that were necessary for maximizing agricultural output.

Citizens of the Eastern Han Dynasty apparently enjoyed a higher standard of living than their Western Han predecessors because of these advances in agricultural technology. Gaozu, Han's first emperor, encouraged land investment and created the trend of landlords controlling larger and larger areas of land, which caused privately owned farms to become rarer. Land reform initiatives during the late Western period and by Emperor Wang Mang during the Xin Dynasty were too late, thwarted by the politically powerful landlords, who also had their land removed from the tax rolls. The private ownership of family farms had once been a source of political stability, but the increasingly overtaxed peasants rebelled in 184 C.E., creating a period of civil wars that culminated in the fall of the last Han Dynasty in 220 C.E.

SIGNIFICANCE

Qin and Han Dynasty agricultural technological advancements avoided what would surely have been disastrous imbalances between food supplies and the growing population. Moreover, it was impossible for citizens during this period to have imagined what an enormous impact these developments would have on every period to follow, up to modern times. Many of these innovations—in irrigation, tilling, sowing, specialized implements, and rice growing—are still used during the early twenty-first century in China's struggle to feed a population in excess of one billion people.

Jack Carter

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■ 200-1250 C.E.

ANASAZI FARMING CULTURE FLOURISHES IN AMERICAN SOUTHWEST

This Basket Maker civilization of the American Southwest emerged, advanced architecture and agriculture, and then vanished.

LOCALE: Four Corners area of New Mexico, Arizona, Utah, and Colorado

AGRICULTURAL ISSUES: Archaeological discoveries; Native American agriculture

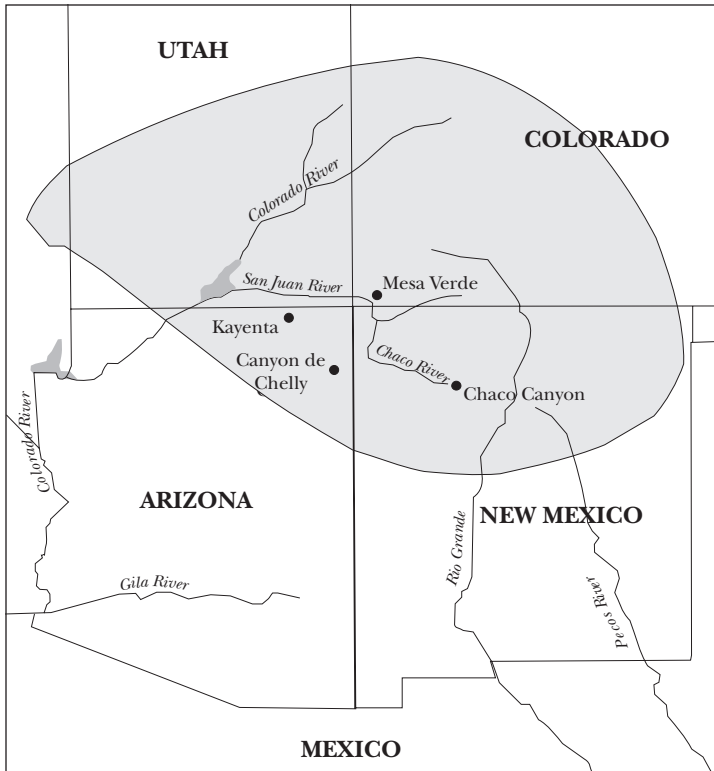
SUMMARY OF EVENT

Believed to be descendants of ancient Desert Archaic people, the Anasazi are one of the best-known prehistoric cultures of the American Southwest. Different groups of Anasazi spoke at least six languages that were not mutually understood. The term “Anasazi” derives from an English-language corruption of a Navajo term, Anaasa’zi, which describes the many stone ruins of the Four Corners region and may mean “ancient ones,” “enemies of the ancient ones,” or “ancient enemy.”

The earliest Anasazi are known as the Basket Makers because of their extraordinary skill in basketry. Initially, these early people occupied a few cave sites and rock shelters along the San Juan River and open sites in the Rio Grande Valley. Inhabitants of these early villages planted maize and squash, a skill learned from their ancestors, and hunted and foraged.

The villages, perhaps occupied seasonally, consisted of a few pit houses: low, circular houses dug into the ground, approximately seven feet (two meters) across. Stone slabs were used for some houses. Upper walls and roofs of many dwellings were made of wood and adobe or wattle and daub. The houses had fire pits and were entered by ladders placed in the smokehole of the roof. Tunnel-like side entries faced the east. Larger pit houses were for ceremonial use. Smaller slab-lined structures were used for storing food. Baskets (some woven tightly enough for cooking), sandals, and other articles were of high caliber, highly stylized with geometric motifs. These de-

ANASAZI CULTURE AREA



signs gave rise to later Anasazi pottery painting traditions. Anasazi rock art of the period shows humans with broad shoulders, trapezoid-shaped bodies, and very large hands and feet. Elaborate headdresses, hair ornaments, necklaces, earrings, and sashes adorn the figures. Found near the villages, the art appears to have been part of community life.

As the Basket Maker Anasazi population grew and their territory expanded, their villages became larger. Almost all had ritual rooms, which the later Hopi called kivas. Pit houses became deeper, more complex, and spacious. Earth-covered wooden roofs were supported by four posts with crossbeams. Some houses were dome-shaped. Storage bins, benches, a central fire pit, and a draft deflector between the fire and the ventilator shaft were found in many dwellings. Roof or side entrances were retained.

Within the village were many outdoor work and cooking areas. Slab-lined storage buildings and ramadas (roofed, open-walled structures shading work and living areas) were built on the surface. Some kivas were modified houses, but many were larger, some thirty-five feet across (eleven meters). Excavated holes called *sipapu* were dug near the center of the floor in many homes and in most kivas. Turquoise or other offerings were placed in the *sipapu*, the opening to the underworld from which people emerged.

Farming became increasingly important to the Anasazi. To ensure successful crops, check dams and devices were used in fields near villages. By 600 C.E., beans, introduced from Mexico, were cultivated. By 700 C.E., cotton, the bow and arrow, and stone tools were used generally. Maize was ground on large stone mortars using two-handed grinding stones.

Basketry, sandal making, and weaving also became increasingly elaborate. Feathers and rabbit fur were woven into robes. Pottery



Well suited to arid climates, squashes originated in the Western Hemisphere and were important food crops in early North and South American cultures.

(©Roman Snytsar/
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making developed as both an occupation and a basis for trade. Pots were used for rituals, storing food and water, and cooking and serving food.

The quantity and variety of rock art increased. Rock art was near or in villages, on mesa boulders, near hunting trails, or in other open locations. Subjects included birds, animals, hunting scenes, and figures playing the flute. Human handprints covered some cliff walls in mass profusion. Home, village, and the kiva were the focus of community life, which endeavored to encourage and ensure agricultural prosperity.

The Pueblo period of the Anasazi began about 700 C.E. Villages varied in size from small complexes to those with more than a hundred dwellings. Architecture gradually developed into rectangular surface buildings of dry masonry or stone and adobe that followed a linear arrangement with multiroom units. Buildings usually faced a plaza located to the south or southeast. One or more kivas were built in the plaza. Kiva architecture included an encircling bench attached to the wall, roof support poles, a central fire pit, a ventilator shaft, and a *sipapu*. The kiva was entered by ladder through a roof opening that also allowed smoke to escape. Jars, bowls, and ladles were frequent forms for pottery. Turkeys and dogs were domesticated. Infants were bound to cradle boards so that the child could be near the mother. By 900 C.E., trade activities and movement of the people had engendered a certain amount of cultural uniformity, although some local differences occurred in agriculture, architecture, and pottery.

The Anasazi realized their cultural apogee between 1000 and 1300. The building of Chaco Canyon, the cliff houses of Mesa Verde, and the ruins of Kayenta date from this time. Many communities of this period and virtually all of the Chaco-style "great houses" were planned or renovated into single, self-enclosed structures. New rooms were attached to older ones. Linear units grew into L-shapes when a room was added at the end of a row to enclose space. L-shapes became U's, and U's turned into rectangles. If a village grew or became old enough, the public space of the plaza was enclosed. "Great kivas" were usually built in the Chaco plazas in addition to smaller ones. Rooms were organized into units of two or three, with a doorway facing the plaza. Ladders led to upper-level units.

The Chaco Canyon district included nine great houses and eigh-

teen great kivas within an eight-mile area. Families occupied suites of rooms in the great houses. Other rooms were for storage, turkey pens, trash, or sometimes burial chambers. Anasazi ate stews of meat, corn mush, squash, and wild vegetables and cornmeal cakes.

Beginning about 1050, the Chaco Anasazi built a complex of twelve elaborate towns that became their religious, political, and commercial center. Grandest of all the great houses was Pueblo Bonito, a five-story D-shaped structure with eight hundred rooms and thirty-seven kivas, covering three acres (a little over a hectare). It took 150 years before the planned village of Pueblo Bonito realized the conceptions of the original designers.

Skilled as astronomers, the Anasazi built celestial observatories on clifftops. Of these, Fajada Butte is the most famous. Three stone slabs lean against a vertical cliff face on which two spiral petroglyphs are carved. Each day before noon, sun daggers fall through the slabs onto the spirals in different places and, depending on the time of year, mark the solstices and equinoxes.

The Chaco Anasazi built an elaborate road system of about 1,500 miles (2,400 kilometers). The 30-foot-wide (9-meter-wide) roads were paved and curbed. Straight paths cut through or were built over gullies, hills, or cliffs. Roadside shrines were constructed in widened parts of the road. These roads may have served some ceremonial purpose.

SIGNIFICANCE

By 1150, the Chacoan culture began to decline. The people of Pueblo Bonito walled up the doors and windows facing the outside of the great houses. Stones closed the entrance to the pueblos, leaving access by ladder only. Slowly the people left the basin, never to return.

About 1100, the Mesa Verde Anasazi began to abandon many small settlements in the mesa. Large pueblos developed, which initially followed the traditional Mesa Verde pattern with the kiva in front of the main dwelling. Soon, the kivas were enclosed within the circle of houses and walls. Stone towers were built, perhaps as watchtowers. Walls were made of large rectangular sandstone blocks with little mortar. Mud plaster was applied inside and out. One hundred years later, the Mesa Verde Anasazi moved into the caves below the

mesa, although they continued to farm the mesa. Some of the cliff dwellings became quite large. Cliff Palace numbered two hundred rooms with twenty-three kivas. The Mesa Verde Anasazi prospered for some time in their cliff dwellings, but decline fell on these Anasazi, too. A savage, twenty-three-year drought occurred in the Southwest. The Mesa Verdeans left as the crisis intensified.

By 1300, few Anasazi remained in their once-large domain. As their legacy they left descendants who became the Hopi, Zuñi, and other Pueblo peoples, as well as some of their religious and social traditions. During the twenty-first century, the adobe pueblos of the Southwest serve as reminders of the great stone houses of their Anasazi forebears.

Mary Pat Balkus

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■ C. 500-1000

RISING SWAHILI CULTURES FOSTER AGRICULTURE IN EAST AFRICA

The rise of Swahili cultures demonstrates an important historical development on the African continent, which also had implications for global maritime trade and commerce. It demonstrated the remarkable capacity of indigenous African cultures to incorporate elements from Islam while maintaining the dynamism of traditional practices.

LOCALE: East African coast and adjacent islands

AGRICULTURAL ISSUES: Archaeological discoveries; Marketing and trade; Tropical produce

KEY FIGURE

ʿAbd al-Malik (c. 646-705), caliph who ruled part of East Africa’s Swahili coast, r. 685-705

SUMMARY OF EVENT

The term “Swahili” derives from the Arabic word *sawāḥil* (the plural of *sāḥil*, which means “coast”). Though it is of Arabic etymological moorings, Swahili does not imply Arabic in its roots. Sayyid Hurreiz, a Swahili scholar, contends that Swahili cultures are dynamic and that Swahili culture in Zanzibar and Kilwa Kisiwani may be different from that in Mwanza and the Comoros Islands, but is African at its roots. Just as with all cultures that have evolved through mutual exchange and interaction with other cultures, Swahili culture is no exception.

The Swahili coast traverses the East African coast and the surrounding islands and extends from Mogadishu in Somalia in the north to Cape Delgado in Mozambique in the south, covering many archipelagos and islands in the Indian Ocean, including the Comoros and Lamu archipelagos, and the islands of Mombasa, Pemba, Zanzibar, Mafia, and Kirimba.

From some of the earliest records of human civilization, the Swahili coast has featured importantly in history. Solomon from the

ancient Hebrew tradition was said to have dispatched vessels to the Swahili coast. Trade in pottery, cloth, and iron implements and commercial exchanges with the nations of Arabia and India made the Swahili coast one of the most prominent geographical coastlines in the world. In the seventh century, Swahilis traded with China.

Following research conducted by coastal archaeologists during the 1980's, the towns of Shanga and Manda were unearthed and revealed a community that thrived from 700 to 1400. Shanga, divided into numerous neighborhoods called *mitaa*, was originally founded as a fishing and agricultural village and eventually was transformed into a maritime metropolis with trading ties with the Arab and Asian world. Africans on the East African coast traded ivory and tortoise shell for iron goods, perhaps as early as the second or third centuries. The heart-shaped iron hoe and the drum-type bellows are just two examples of such iron implements. The mythological work, *Periphus Maris Erythraei* (*The Periphus of the Erythraean Sea*, 1912), a work of mythology by an unknown Greek writer of the first century, described trade between the Greeks and Romans and Arabs in the north, and Africans on the East African coast. Though such accounts are not historically reliable, they do point to a flourishing exchange of cultures between East Africans and other peoples.

In direct challenge to the erstwhile Eurocentric view that portrayed Swahili civilization as an essential product of its merging with Persian and Arab cultures, archaeologists have now conceded that the presence of sun-dried clay and timber homes along the Swahili coast denotes continuity with such residential styles in other parts of Africa, which, therefore, substantiates an unequivocal African origin. Some archaeologists have insisted that the coral or clay structures do not point to an African origin because the Africans were nomadic. However, Swahili scholar Richard Wilding has demonstrated that the coastal cultures and those of the hinterland were not radically disparate in character, but rather had much in common. Findings that include ceramic motifs and similar cooking vessels, for example, establish this connection.

Wilding argues that the original Swahili coastal residents were Cushitic pastoralists and foragers and that Bantu-speaking groups merged with these pastoralists at a later period. Similarly, Sayyid

Hurreiz maintains that these pastoralists migrated southward from Abyssinia (now Ethiopia) and the Nile Valley and mixed with the Bantu people on the lower East African coast whose language was Kingozi. It was the Kingozi culture and language that provided the basis of Swahili language and culture. Another theory suggests that the inhabitants of Pate Island off the East African coast are the early Swahili or proto-Swahili, who may have been speakers of proto-Sam, an African language considered to be the parent tongue of the Boni, Somali, and Rendille in East Africa.

Shungwaya was the original home of the Swahili. Two other known towns were established before 800, namely Rhapsa and Kanbalu, the former located in or near the Rufiji Delta below Somalia. Around 800, the language later known as Swahili began to be spoken, and people moved into Swahili settlements called *mji*.

The Swahili coast was inhabited by a diverse population, with pastoralists and agriculturists living on the northern coast in what is now Tana Delta and the Lamu archipelago and sedentary farmers and ironworkers living on the southern coast. These communities lived in interdependent economic and social relations with each other and subsequently developed the Swahili culture.

The period 300 to 1000 was a time of intense international trade along the Swahili coast. Around the seventh century, Arab communities settled in East Africa during the reign of the Islamic caliph 'Abd al-Malik. The *Khabar al-Lamu* (*A Chronicle of Lamu*, appearing in *Bantu Studies*, vol. 12, no. 1, 1938) and other sources, not factually reliable in every manner because they are based on the fluidity of oral tradition, describe these Arab Islamic settlements. Stories abound about Arabs fleeing political and religious persecution in the Arabian peninsula, but the veracity of these accounts is difficult to confirm.

Felix Chami, a Tanzanian archaeologist, divides this period into the Azanian phase—from 300 to 600—and the Zanjian phase—from 600 to 1000. The term *zanj*, used by Arab marine traders, referred to “the land of black people.” Entrepreneurial activity boomed during this period, with expanding settlements and increased imports of pottery, including ceramics from Iran, China, India, and Egypt. The sea was key in the development of Swahili society. Settlements were built on beaches or small inlets adjacent to the sea.



As in other parts of the tropical world, coconut palms can be found throughout much of Africa. (PhotoDisc)

International cultural influences were inevitable, and the design and look of Swahili pottery changed, evidenced by findings at Tana. During the Zanjian phase, the influx of Middle Eastern and Indian styles prominently modified existing Swahili pottery design. During the Azanian phase, houses were relatively small in size and were constructed of sun-dried clay and palm fronds. People hunted game, fished, kept livestock, cultivated cereals, traded, and engaged in local and regional commerce and exchange.

Canoes and sewn planked boats were used for fishing, and anglers used hooks and lines, harpoons, nets, and basket traps. Mostly shellfish and turtles were caught. The Swahili farmed extensively, cultivating indigenous crops such as sorghum, millet, eleusine, rice, peas, beans, sugarcane, coconuts, bananas, and taro from Southeast Asia. They cultivated fields, planted seeds with sticks, weeded with hoes, and harvested crops, threshing and winnowing grain. They raised chickens and some livestock such as cattle, goats, and sheep.

Iron smelting was another distinctive feature of this time period. Iron slags have been found at Kilwa Kisiwani, Manda, Shanga, Galu,

and Ungwana. The Swahili produced their own fishhooks, spearheads, and arrowheads and probably their own agricultural implements. They may have manufactured cotton cloth and carved pots in a unifying cultural style along the coast, trading these along with numerous other goods with other mariners from Arabia and Persia in the north and India and China in the east.

SIGNIFICANCE

Swahili peoples developed into a prosperous commercial society over the centuries as traders, farmers, and foragers all forged a common Swahili identity. The religious and cultural evolution evidenced in the Swahili culture of the Zanjian phase has come to define the very complex character of African Islam during the early twenty-first century.

The development and expansion of Swahili cultures and language furnish models of indigenous African technical and economic ingenuity from which other cultures of the period benefited and from which the modern coastal cultures of Africa can learn.

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C. 500-1000

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■ C. 500-1000

TIWANAKU CULTURE DEVELOPS COLD-WEATHER AGRICULTURE IN ANDES

The Tiwanaku civilization became the second great empire in the Andean highlands, flourishing because of its unique agricultural methods, which adapted to extremely cold weather, and because its political system sought to unify and incorporate rather than transform or remake outlying territories.

LOCALE: Lake Titicaca basin, border of Peru and Bolivia

AGRICULTURAL ISSUES: Drought; Ecology and environment

SUMMARY OF EVENT

Tiwanaku, located more than 12,500 feet (3,810 meters) above sea level in the Central Andes, was the capital of a civilization situated at the highest elevation of any world empire for more than five hundred years. Its origins lie during the early Intermediate period, from c. 200 B.C.E. to c. 200 C.E. (also named Tiwanaku phases I, II, and III). During this period, Tiwanaku began as one of several small temple dominions, political clusters that united agropastoral communities around Lake Titicaca. Subsistence was based on the cultivation of tubers (potato, oca, ullucu) and native grains (quinoa, cañihua), supplemented with meat from herds of llamas and alpacas and fish and waterfowl. Villagers lived in rectangular and circular houses of stone set in mud mortar, with thatched roofs.

The Pajano religious tradition dominated the area, with a variety of local religious practices and cosmologies, but during the Early Intermediate period, there was a syncretic convergence into a more uniform, standardized religious tradition, with particular emphasis on dualism, metamorphosis, and fundamentalism, known as Yaya-Mama. Religious observances were centralized in the larger villages, where ritual structures included platform mounds, sunken rectangular temples, and associated plazas with stone monoliths, sculptures, and plaques depicting the deities.

During this period, there was additional investment in landscape capital, especially the increased construction of raised fields and ca-

nals. The canals were built either parallel or at right angles to the sun's path, resulting in the maximum capture of solar energy, which, when radiated at night, protected the fields from frost and freeze losses because of the city's high elevation. The canals also mitigated the impact of both excessive rainfall and drought, greatly reducing agricultural risk.

By the latter half of the Early Intermediate period (c. 200-c. 600), Tiwanaku was flourishing. Smaller local groups began coalescing into a few hierarchical settlement clusters in the Tiwanaku region. At Tiwanaku itself, a subterranean temple was built, along with the central sunken courtyard of the Kalasasaya temple. The nearby village of Iwawe was established as a lake port, principally for the importation of andesite for construction purposes. In the adjacent pampa areas, intensive farming became more important, and large quantities of basalt hoes were being imported. By the end of the Late Formative period from about 200 to 500 and overlapping with the Early Intermediate (also called Tiwanaku phases I-III), Tiwanaku had emerged as the area's primary center and had cemented its control over the religious and political spheres enough to begin its expansion out of its local valley.

The more specific time period called Tiwanaku IV (c. 500-c. 800), the first period of Tiwanaku hegemony over surrounding areas, is marked by the promotion of a state suite of ideologies, sacred symbols that served as markers of status and identity through a kind of theater state, and reciprocal relations between the elites and local groups, in which direct control of production (such as craft fabrication and agricultural activities) remained in the hands of a nested hierarchy of local groups integrated into reciprocal state obligations through elaborate feasting practices.

The theater state was centered on a series of grandiloquent public temples in the heart of the city, most of which were enclosed within a large, rectangular, moated precinct. Tiwanaku was a planned city, with its sewer system, roads, entry gates, and ritual structures laid out along cardinal axes. The architecture was aligned within a few degrees of the cardinal directions (the north-south axis usually 6 to 11 degrees east of true north), with major doorways, ramps, and entrances to these temples on an east-west axis aligned with the sun's path. The buildings displayed megalithic construction, employing

stones up to 131 tons (119 metric tons) in weight. Because of the lack of mortar, large stones were held in place by gravity or secured by copper and bronze clamps set in drilled holes. Floors were constructed of red, green, or other deliberately colored clays, and walls show remnants of polychrome murals.

Images of the deities were on wall plaques and massive stone stelae up to twenty-four feet (7.3 meters) high. Some stelae show evidence of being covered with gold leaf and multicolored painting. The priests communed with the gods with the help of hallucinogenic drugs. One of the most typical Tiwanaku artifact assemblages is the hallucinogenic complex, comprising carved stone mortars and pestles, stone bowls and cups, wooden snuff trays, pottery incensarios and bowls, wooden and bone snuff tubes and spoons, specialized textiles, and gold and ceramic keros, all decorated with sacred images. Control of symbolic knowledge was more important than control of resources.

Politically, Tiwanaku was more an incorporating than a transforming polity. During Tiwanaku IV, the political organization was a loosely centralized, segmentary state, built on a nested hierarchy of local territorial segments called ayllus. Tiwanaku was an archaic state of limited means that carefully expanded into a few key strategic areas, beginning c. 600-650. It employed multiple strategies to integrate state and local power as the situation mandated, using both direct and indirect mechanisms for political control, employing federation, annexation, colonization, conquest, ports of trade, or locally inserted *mitmaqkuna* groups. Areas of direct control included the establishment of new sites, state intensification of agricultural production, formalization of road systems, resettlement of major portions of the population, and specialization of production, while areas of indirect control exhibited a variety of other policies utilized to co-opt local elites or secure mutual political benefit. Militarism seems to have been little employed; there are no known fortifications of Tiwanaku culture, and illustrations of warriors are rare.

The economy appears to have been based primarily on staple finance, rather than wealth. There was no apparent merchant class, and during Tiwanaku IV, there is little evidence of top-down managed state production. The city seemed to be composed initially of small multiethnic neighborhoods, swollen at periods by massive



Adapting techniques developed during the Tiwanaku culture era more than a millennium earlier, modern farmers living on the Andean altiplano make efficient use of the rugged terrain. Intensive cultivation gives this altiplano peak the look of a patchwork quilt. (Clyde L. Rasmussen)

numbers of visiting pilgrims. Production was a cottage industry, rather than state organized, controlled by the household or ayllu. The cottage industries included both fancy ceremonial ceramics and quotidian daily wares; lithic workshops in which obsidian arrowheads and basalt hoes were produced; lapidary areas in which sodalite, turquoise, and other decorative items were fabricated; and possibly areas in which metal items were produced, including the tin and ternary nickel-tin bronzes that first appeared in the Andes during the Tiwanaku period. The limited distribution of these materials outside of Tiwanaku, as well as their extremely standardized forms, suggests that even though they were crafted in residential compounds, distribution was controlled by elite groups.

The relationship between elites and commoners was of reciprocal obligation. Evidence for reciprocity comes from the large quantity of serving dishes, storage jars, and refuse found near the major theater-state temples associated with the feasting events, and the evidence is

supported by the fact that corn rose suddenly in importance at Tiwanaku. Corn generally cannot be grown at that site's altitude, but it is the main ingredient in *chicha* (a beer made from fermented corn), a critical component of Andean feasting events.

The end of Tiwanaku IV was marked by increasing status differences and social hierarchies. There was a gradual fragmentation and reorganization of the socioeconomic base. Early Tiwanaku V (800-1000) was typified by a period of sociopolitical, economic, and ideological consolidation and was marked by a series of massive urban renewal projects. Large sectors of both the ceremonial core and the residential zones were razed, with new structure types built in their place. Late Tiwanaku V (1000-1150) was a long phase of environmental crisis, political disintegration, and settlement dispersal.

SIGNIFICANCE

The initial Tiwanaku state rose because of its laissez-faire political approach, which resulted in the creation of a polity that survived for an exceptionally long period. The shift in strategies in Tiwanaku V, around 1000, to seizing more direct control over certain regions, transforming their relationships from alliance or federation into state-administered provinces, began its demise. The Tiwanaku V political approach became openly exploitive and thus onerous to the subject populations. In Late Tiwanaku V, environmental conditions deteriorated, exacerbated by a severe long-term drought. Political allegiances and control slowly eroded; gradually many areas dropped their allegiances or linkages with the Tiwanaku state. The final collapse of Tiwanaku was both a cultural revolution that resulted in the formation of an entire new set of sociopolitical alliances and a corresponding new set of agropastoral productive strategies; it was as much the result of sociopolitical fragmentation as it was of environmental determinism.

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■ 7TH-13TH CENTURIES

MOGOLLONS ESTABLISH AGRICULTURAL SETTLEMENTS IN AMERICAN SOUTHWEST

The Mogollon were one of the earliest and most successful of the Pueblo peoples. Although traceable to well before the common era, Mogollon culture changed slowly until around the seventh or eighth century.

LOCALE: Southwest United States and northern Mexico

AGRICULTURAL ISSUES: Archaeological discoveries; Hunting and gathering; Native American agriculture

SUMMARY OF EVENT

The Mogollon people were named for the Mogollon Mountains, the southern parts of Arizona and New Mexico where remnants of their culture were first discovered. Prior to 1930, what is now recognized as Mogollon culture was considered a regional variation of Anasazi or Pueblo culture. During the 1930's, Harold Gladwin and Emil Haury recognized the Mogollon as a separate people from the Anasazi and Hohokam, who together constituted the three primary cultural divisions of what are commonly referred to as the Pueblos. Mogollon civilization flourished between approximately 300 B.C.E. and 1300 C.E.

Mogollon culture evolved from a seminomadic hunting, gathering, and agrarian way of life into one that was village-centered. In addition to cultivated foods, the Mogollon consumed a variety of wild plants, such as piñon nuts, walnuts, juniper beans, and cactus, as well as small animals and deer. There was, of course, some regional variation in the food that was available to them, variations between the hotter, drier desert regions and the cooler, wetter mountainous regions.

For centuries, the Mogollon hunter-gatherers had supplemented their diet with cultivated food. By the sixth century, cultivated produce, particularly maize, formed a large portion of their daily diet. However, around this time, for some unknown reason, the amount of cultivated food consumed appears to have decreased by as much as 80 percent, while the amount of wild plants and animals consumed



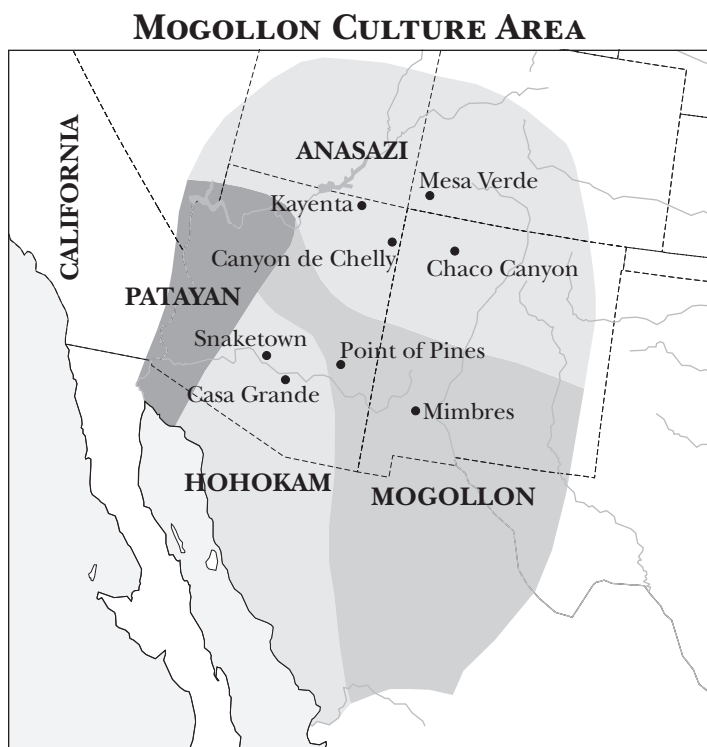
Early twentieth century Hopi woman using traditional implements to grind corn kernels. As modern heirs to Mogollon culture, the Hopi owe many of their agricultural practices to Mogollon developments. (Library of Congress)

increased proportionally. During the eighth century, this trend was reversed, as cultivated foods such as maize, beans, and squash once again constituted a larger part of the diet. Tobacco was also cultivated and used both socially and ceremonially. Along with this resurgence in agriculture came significant changes in the size, construction, and location of Mogollon villages. Early settlements were generally located in high, easily defensible sites but later were found in lower, more arable locations.

The Mogollons developed pit houses, roundish, excavated pits that were two to five feet (one to two meters) deep and covered with an elevated roof of poles, brush, and mud. Early single-room pit houses began to evolve into multiroom, above-ground dwellings during the late tenth and early eleventh centuries. Whereas earlier settlements were small and usually consisted of fewer than a dozen structures, by the thirteenth century, the size and number of structures had increased to form villages. However, most villages contained no more than thirty or so houses, although some villages, especially in

the southern region, did have two-story multifamily structures. Located at the heart of each settlement was a plaza that served as a place for both domestic and ceremonial activities. In addition to family dwellings there were storage and ceremonial structures. The latter are known as kivas, some of which were small, circular, and subterranean, whereas others, known as great kivas, were larger, rectangular structures. Around the eleventh century, single-story, multifamily dwellings, which contained from fifty to two hundred rooms, were constructed in some Mimbreno villages. The Mimbreno, renowned for their pottery, were a subgroup of the Mogollon who lived along the Mimbres River and several smaller distributaries in southwestern New Mexico.

The Mogollon were among the first people in the Southwest to make pottery, possibly influenced by their Mesoamerican neighbors to the south. The earliest pottery consisted of plain and polished red- or brown-colored vessels made by the coil-and-scrape method. This



entails forming the clay into long strips and building the vessel by placing one coil on top of the other to create the desired shape, then smoothing the surface with a scraper. This type of pottery making continued through the entire existence of the Mogollon people. Around the fifth century, a red-on-brown design was added, and several centuries later, a type called Three Circle red-on-white appeared. During the tenth and eleventh centuries, a type of indented, corrugated brown pottery became popular. Paints used on this pottery were generally produced from minerals rather than by boiling plants (a method of the neighboring Anasazi), although the Mimbreno did use the extract of dried plants. What is generally considered the most beautiful and prized pottery is the pottery developed along the Mimbres River, a type believed to have been influenced by the Anasazi.

This pottery, which became popular between the tenth and thirteenth centuries, was black-on-white with stylized depictions of humans, birds, fish, insects, and mythical creatures along with geometric designs. The human depictions were often narrative in nature, showing aspects of daily life. Some pottery depicted human sacrifice, or even a horned or feathered serpent, important in Mesoamerican and southwestern cosmology. Mimbreno bowls from the eleventh and twelfth centuries sometimes depicted prayer sticks with feathers attached, similar to those used by modern Pueblo peoples. Certain designs appear to be more common in certain areas, leading to speculation that these may identify or represent particular lineages or communities. Pottery was often “killed” (deliberately broken) by punching a single hole at its bottom and placing it in the grave of its former owner. At the height of the Classic Mimbreno period (1000-1150), the population of Mimbres Valley settlements was estimated at five thousand. The Mimbreno population peaked and then declined in the twelfth century, along with the production of their distinctive pottery.

Trade between neighboring peoples appears to have been common throughout the area, and unprecedented population growth took place from the eleventh to the thirteenth centuries. However, the greater numbers and higher density put a strain on the area’s limited natural resources. Not only was there competition for wild foods, but the increased depletion of trees for building and fuel would have

had an impact on the plant and animal life that was part of the ecosystem supplementing the often precarious harvest.

Ironically, the growth in population ultimately appears to have been a factor in the decline of the Mogollon civilization, a decline that occurred around the twelfth and thirteenth centuries. During this time, some people abandoned the more densely inhabited areas. By the end of this period, many villages had been abandoned, including those along the Mogollon Rim and the Little Colorado River and its southern distributaries. Some people moved north into Anasazi territory, and others moved back to the more elevated sites and constructed perimeter walls, possibly for defensive reasons. By the thirteenth century, Mogollon culture was increasingly exhibiting characteristics of the Anasazi culture. It appears the Mogollons eventually merged with their Anasazi neighbors to the north.

SIGNIFICANCE

The Southwest is the region with the oldest continuous record of human habitation in what is now the United States. Pueblo peoples such as the Mogollon have been, and continue to be, important inhabitants who have adapted to, rather than attempted to change, the nature of the region.

The changes in Mogollon culture that began in the seventh century, including an increase in population, affected not only the people at the time but also to some degree the present-day Pueblos. Over time the Mogollon adapted to this population increase by developing settlements from subsurface to surface and single-family to multifamily structures. Their agricultural practices improved, as did their pottery making.

Aspects of Mimbreno culture can be seen in modern Pueblo villages of the Taos, Acoma, and Hopi of northern New Mexico and Arizona. Mimbreno pottery is prized by both collectors and museums, and their designs can be found during the early twenty-first century on such items as posters and T-shirts. Accumulated knowledge and experience has been passed on to succeeding generations, and it is believed that the modern Zuñi may be descendants of the Mogollon. The Mogollon and Mimbreno are sometimes included with the Gila Apache, along with the Gileno and Tonto.

Philip E. Lampe

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CHINA'S GRAND CANAL IMPROVES AGRICULTURAL TRADE

Yangdi, the second emperor of the Sui Dynasty, integrated the fragmentary waterways between the Yellow and Yangtze rivers into a nationwide water transportation system known as the Grand Canal. The improved transportation provided by the canal made possible shipment of agricultural products into food-deficient regions.

LOCALE: China, Yellow and Yangtze rivers, Luoyang, Dadu (Xi'an), Beijing, Hangzhou, Yangzhou

AGRICULTURAL ISSUES: Innovations; Marketing and trade

KEY FIGURES

Wendi (Wen-ti; 541-604), founder and first emperor of the Sui Dynasty, r. 581-604

Yangdi (Yang-ti; 569-617), second emperor of the Sui Dynasty, r. 604-617

SUMMARY OF EVENT

Yang Guang (Yang Kuang), known as Yangdi, the second emperor of the Sui Dynasty (581-618), is often associated with canal building, but it was his father, Wendi, who initiated construction of the canal system. In 584, Wendi decided to build a canal from the capital at Chang'an (present-day Xi'an) eastward to the strategic Tong Pass near the confluence of the Wei and Yellow rivers. This canal, known as Guangtong Qu ("canal for expanded communication"), allowed the government to resolve the problem of food shortage by transporting grain from the fertile plain in eastern China to the capital region, a food-deficient and heavily populated area. Wendi also constructed a granary at the eastern end of the canal to serve as a center of grain storage for distributing food supplies to the capital and other regions during famines.

Shortly after he succeeded to the throne, Yangdi expanded the canal system. By 610, he had completed the Grand Canal (Dayunhe),

the world's largest human-made waterway stretching more than one thousand miles (1,600 kilometers) in length. Because the major rivers in China flow from west to east, the Grand Canal, running north to south, was significant in that it integrated several regional waterways into an empire-wide system of water communication. Tongji Qu, Han Gou and Jiangnan He were the three canals that were built between the Yellow and Yangtze rivers, and Yongji Qu was the only section constructed north of the Yellow River.

Tongji Qu (canal for effective communication), built under the order of Yangdi in 605, linked the newly established eastern capital at Luoyang on the Yellow River with the Huai River Valley and connected with another old canal to the Yangtze River. All the links in this canal followed the courses of earlier waterways and transformed the Yellow and Yangtze rivers into a well-integrated network of inland river communication. As many as five million men and women were mobilized to carry out the construction work, and an imperial road was built along the canal banks. To further expand into Yangzhou city on the Yangtze River, Yangdi incorporated into this canal the ancient Han Gou (Han waterway), first built during the early fifth century B.C.E. and restored by Wendi as Shanyang Qu (Shanyang canal) in 587.

The portion of the Grand Canal south of the Yangtze River was Jiangnan He (canal in the Lower Yangtze Valley). Completed in 610 and more than 270 miles (435 kilometers) long, this canal was built on existing rivers in the Lower Yangtze Valley. It reached the eastern side of Lake Tai and connected Hangzhou Bay with the Yangtze River.

These three canals directly connected the Yellow and Yangtze River systems, two of the greatest and most changeable rivers in the world. Using the canals, boats could easily transport grain from the rice-growing fields of the area south of the Yangtze River to the capital region without having to sail along the East China coast. Granaries were built at many places along the route so that grain could be stored if flood or low water levels hindered transportation.

The longest section of the Grand Canal was Yongji Qu (canal for everlasting prosperity), north of the Yellow River and more than 620 miles (998 kilometers) in length. This canal followed the course of a river descending southward from the Taihang Mountains and

merged with the Wei River to flow northeastward to Beijing. Built largely for strategic reasons and finished in 609, the canal allowed the government to supply the troops stationed at China's northeastern frontier. Between 611 and 614, Yangdi sent huge expeditionary forces along this canal to attack the kingdom of Koguryō, which controlled the part of Manchuria east of the Liao River and the north of the Korean peninsula.

SIGNIFICANCE

The Grand Canal was of great political, economic, and social significance. After many decades of civil war and political disintegration, China had recently become unified under the Sui government. The Grand Canal demonstrated the wealth and power of the dynasty. In times of crisis, the government could easily distribute resources and send large numbers of soldiers to the troubled regions. Strategically, the canal system integrated the southern and northern frontiers into the heart of China and laid the framework of a highly centralized imperial state.

As a great work of hydraulic engineering in seventh century China, the Grand Canal was the first fully integrated nationwide water transportation system and performed the same function as the Nile River did for Egypt and the Mediterranean Sea for Constantinople in the medieval era. This inland river system formed the basis of a unified economy. Although the Lower Yangtze Valley was the major economic area, the political center was located at the food-deficient region in the north. The canal system enabled the government to transport grain from the rest of the country to support the growing population in the capital region. In the long run, it laid the foundation for the brilliant epoch of the Tang Dynasty (T'ang; 618-907), widely regarded as China's golden age. Parts of the Grand Canal are still in use during the early twenty-first century, especially the sections south of the Yangtze River.

Despite these advantages, Confucian scholars who wrote the dynastic history were very critical of Yangdi for building the Grand Canal. They often compared Yangdi with Shi Huangdi, the first emperor of the short-lived Qin Dynasty (Ch'in; 221-206 B.C.E.), who created a unified and centralized imperial state but exhausted national resources in building the Great Wall. They also regarded the



Fourteen centuries after its completion, China's Grand Canal is still an important waterway. This picture from 1901 shows men using trained cormorants to catch fish in the canal at Suzhou, near the central coast. (Library of Congress)

Grand Canal as a key factor leading to the collapse of the Sui Dynasty. The *Kaihe zhi* (seventh century; record of the opening of the canal), an anonymous Sui text, throws light on the effect of canal construction on the people. Reportedly, more than five million workers had been mobilized to work, and every fifth family had been required to send one person to supply and prepare food for the workers. Those who failed to comply with the official regulations were severely punished, and more than two million people were said to have died. These figures reveal the tremendous loss of human life that occurred as a result of the construction. Because Yangdi completed the Grand Canal in such a quick and ruthless manner, he provoked much discontent against his rule and failed to attain a long period of peace and stability. It was the succeeding Tang Dynasty that enjoyed all the benefits from and owed much of its prosperity to the Grand Canal.

Joseph Tse-Hei Lee

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TANG DYNASTY IMPROVES CHINA'S AGRICULTURAL PRODUCTIVITY

A newly reunified China became the most powerful state in East Asia. Its material wealth allowed first for an explosion of culture and significant improvements in agricultural productivity and later a flourishing of Buddhism.

LOCALE: China

AGRICULTURAL ISSUES: Government policy and regulation; Population growth; Tropical produce

KEY FIGURES

Wendi (Wen-ti; 541-604), founder and first emperor of the Sui Dynasty, r. 581-604

Li Yuan (Li Yüan; 566-635), founder and first emperor of the Tang Dynasty, r. 618-626

Xuanzang (Hsüan-tsang; c. 602-664), Chinese monk and religious leader

Huang Chao (Huang Ch'ao; 852-884), rebel leader

SUMMARY OF EVENT

When the Han Dynasty (206 B.C.E.-200 C.E.) collapsed, China slipped into 350 years of political and social chaos. This period of instability eventually ended when the Sui Dynasty (581-618) came to power and set China back on the road toward political unity. The new emperor, Wendi, set in motion a series of public works projects; among the most notable was the construction of the Grand Canal. To create this waterway, Wendi's civil engineers essentially connected a series of preexisting canals that would form a 1,200-mile (1,930-kilometer) corridor linking the economies of northern and southern China.

The Sui also launched a series of military expeditions against China's mainland neighbors and eventually invaded the Korean peninsula. The initial success of these campaigns was short-lived, and a series of tactical reverses, especially in Korea, resulted in the deaths of thousands of soldiers. These military failures, coupled with years

MAJOR RULERS OF THE
TANG DYNASTY

<i>Reign</i>	<i>Ruler</i>
618-626	Gaozu (Li Yuan)
627-649	Taizong
650-683	Gaozong
684	Zhonggong
684-690	Ruizong
690-705	Wu Hou
705-710	Zhongzong
710-712	Ruizong
712-756	Xuanzong
756-762	Suzong
762-779	Daizong
779-805	Dezong
805	Shunzong
805-820	Xianzong
820-824	Muzong
824-827	Jingzong
827-840	Wenzong
840-846	Wuzong
846-859	Xuanzong
859-873	Yizong
873-888	Xizong
888-904	Zhaozong
904-907	Aizong

of high taxes and forced labor related to the emperor’s public works projects, led to rebellion and to the eventual defeat of Sui forces.

One of the leaders of the rebellion, Li Yuan, capitalized on the destruction of the Sui Dynasty and declared that the mandate of heaven (heavenly approval of rule) had passed into his hands, and he established a new dynasty known as the Tang (T’ang; 618-907). This new government would usher in an era of Chinese dominance in East Asia.

Like most of the Tang emperors, Li Yuan, who is known as Gaozu (Kao-tsu), created a political philosophy that was a blend of Confucianism and Legalism. This philosophical synthesis actually mirrored the personal characteristics of Gaozu and his successors.

The emperor was more than willing to execute anyone who posed a potential political threat, and this “Legalist” attitude enabled him to structure a stable political environment. Once power was assured, Gaozu installed a Confucian system that created a governmental bureaucracy based on the merit of competitive civil service exams. These actions created an environment of peace and prosperity that formed the foundation of China’s next golden age.

One of the Tang Dynasty’s greatest developments was the restructuring of the Chinese economy. In the agricultural sector, the government introduced the equal-field system that allocated land according to the needs of the individual Chinese family. The impact of the sys-

tem was twofold. It guaranteed that every Chinese household would be working on rich fertile land; this ensured that the people's labor would be rewarded with bountiful harvests and economic security for their families. Most important, the equal-field system prevented the accumulation of large tracts of land by wealthy aristocrats that was the root cause of the peasant rebellions during the Han Dynasty.

The productive potential of the equal-field system was unleashed at the same time that the government introduced a new, fast-ripening strain of rice into the Chinese agricultural sector. This new species allowed for multiple harvests that significantly increased the supply of food, which in turn had an important impact on Chinese demography. The population of China increased from about 45 million to about 115 million between 600 and 1200. This agricultural security and increased population affected the Tang Dynasty in two important ways. The number of peasants needed to produce rice was reduced, and this in turn allowed many Chinese to specialize in certain cash crops that accelerated the commercialization of Chinese agriculture.

Regions began to specialize in certain fruits and vegetables, and the same expanded transportation network that distributed these luxury crops throughout the empire also supplied these same regions with rice. This set the stage for the world's first integrated national economic system.

Increased population also led to the growth in urbanization. In numbers unprecedented in Chinese history, people moved into cities across the empire. Initially, this expansion took place in cities along major transportation routes and in centers of governmental authority. Most modern historians believe Chang'an (now Xi'an), the capital of the Tang Empire, had the largest concentration of people on the face of the earth at the time. Demographers estimate some two million people lived within the confines of the city.

In conjunction with this vast agricultural explosion, China also experienced significant growth in its industrial sector. The dynasty's metallurgic industry grew significantly during this period. Strong, inexpensive iron provided the agricultural sector with highly efficient farm implements and supplied the military with the latest advances in weaponry. Technologically, this period witnessed the Tang's introduction of the use of gunpowder and the magnetic compass.

The wealth of the Tang Empire set the stage for a magnificent cul-

tural explosion. The growth of cities had a deep impact on the culture of the Tang Dynasty. The combination of trade and great wealth created one of history's great cosmopolitan societies. Merchants, scholars, and diplomats from all over the Eurasian land mass could be found in China's great cities. Great restaurants, teahouses, and theaters catered to the varied interests and tastes of this multicultural society. A diversity of religious, political, and philosophical views intermingled and, on many occasions, challenged traditional Chinese cultural practices and beliefs.

Buddhism, which was the most important competitor to established Chinese belief systems, was introduced to the Middle Kingdom (China) by merchants traveling along the Silk Road during the Han period. Not unlike Christianity during the decline of the Roman Empire, Buddhism gained an important following during the great period of self-doubt at the end of the Han Dynasty. The traditional Confucian system seemed to be failing; consequently, this new religion offered a comforting alternative during this period of societal collapse.

The same held true during the Tang period of great wealth. When China began to experience the corruption and moral decline that often accompanies material excess, many people from all levels of Chinese society began to look for antidotes to their spiritual malaise. Buddhism offered an attractive alternative to the traditional Chinese belief system. Members of the elite were impressed with the religion's intellectual sophistication. They were also attracted to the belief of salvation in another life based on the moral and ethical actions of the individual in this life.

The most important proponent of Buddhism in China was Xuanzang, a neo-Confucian scholar. After training and studying in India, Xuanzang returned to China and advanced the cause of Buddhism in East Asia. His greatest contribution was his translation of major Buddhist texts into Chinese.

In addition, the great economic strength of the Tang allowed the government to develop a successful and highly aggressive military and foreign policy. The Tang believed that they controlled the mandate of heaven and that China was truly the Middle Kingdom at the center of the cosmos. Taken literally, this meant that the rest of the world was beneath the status of China and should be treated accord-

THE TANG EMPIRE DURING THE 8TH CENTURY



ingly. Tang international policy was essentially based on a Confucian superior/subordinate relationship. The government implemented a tributary system in which other nations paid homage to the emperor through taxes, gifts, and acts of loyalty. Tang armies conquered Korea and transformed the peninsula into a political and cultural satellite. The new Korean bureaucracy was established on the Confucian model, with its new capital, Kumsong, constructed along the lines of the Tang center of government at Chang'an. Confucianism became the dominant belief system of the Korean upper class, with its political philosophy dominating Korean education. This Confucian connection led to a cultural exchange system that helped cement Chinese culture on the peninsula. Buddhism, which had challenged Confucianism on the mainland since the fall of the Han Dynasty, became widely accepted by the Korean peasants.

The Tang Dynasty also made incursions into Southeast Asia. Most important, the empire attempted to reestablish control over Vietnam. Sino-Vietnamese diplomatic and military conflicts had been a part of Chinese history extending as far back as the Han Dynasty. Chinese emperors found that the Vietnamese jealously guarded their independence; as a result, many a Chinese general felt the sting of Vietnamese military power.

SIGNIFICANCE

Over time, the Tang Dynasty's civil and military leadership became careless and corrupt. Uprisings occurred throughout the empire; the most prominent of these was led by Huang Chao and lasted from 875 to 884. Faced with widespread decline in the dynasty's centralized authority, the empire splintered and collapsed in 907. Subsequently, China entered into a period in which regional military governors ruled independent feudal kingdoms. Most important, Chinese intellectuals would begin to question the aggressive attitudes and policies of the Tang military. By the rise of the Song Dynasty (Sung; 960-1279), the Confucian elite succeeded in putting the military under civilian control. This new bureaucracy was to be governed by the conservative Confucian ethical system that would successfully reduce the power and prestige of the Chinese military.

Richard D. Fitzgerald

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■ C. 700-1000

HEAVY PLOW INCREASES EUROPEAN AGRICULTURAL YIELDS

The use of the heavy plow increased agricultural yields, eliminating the need for cross plowing and allowing for the cultivation of rich, damp soils in northern Europe.

LOCALE: Northern Europe

AGRICULTURAL ISSUES: Archaeological discoveries; Climate change; Draft animals

SUMMARY OF EVENT

Throughout the Middle Ages, farming remained the most important economic activity in Europe. It absorbed the daily labor of nearly all inhabitants and determined social customs and practices. Development and widespread use of the heavy plow, which began gradually in Europe between the eighth and eleventh centuries, was the principal transformation in rural life during this period.

The new wheeled plow, fitted with a coulter or heavy knife fixed to the pole to cut vertically into the soil, a flat, asymmetrical plowshare set at right angle to the coulter to cut the earth horizontally at the root level, and a moldboard to turn the sliced turf to the left or right and create furrows, did not immediately supplant the earlier scratch plow that was fitted with a symmetrically shaped share that merely broke the ground and threw the earth to either side depending on where the “ears” were attached.

The advantages of the scratch plow were its lightness, ease of assembly and handling, and low cost. A single plowman could fit together its wooden pieces that were sometimes reinforced with metal strips. The scratch plow could be pulled by a team of oxen and operated by a lone plowman. This plow remains in use in the Mediterranean areas of Europe where the soils are thinner and the climate more arid. In these regions, the heavier wheeled plow brings too much precious moisture to the surface and thereby reduces fertility. Although it was easier to manipulate and cheaper to operate, the

*Early twentieth century
Russian farmer working with
a primitive scratch plow.
(Library of Congress)*



scratch plow required intense manual labor and could not be used efficiently on the heavier soils of northern Europe. Also, because it left a wedge between furrows, cross plowing was necessary. Thus, each field had to be plowed twice. In addition, the fields had to be dug with spades as often as every four years.

The wheeled plow overcame these disadvantages and proved suitable to the heavier turf and damper climate of the north. Its origins can actually be traced to imperial Roman times. Pliny refers to its presence in the lands south of the upper Danube River and archaeological evidence indicates its use in the areas inhabited by Slavs, Bulgarians, and Byzantine peoples on the lower Danube, as well as along the North Sea. A hoard of tools uncovered at Osterburken, dating from the fifth century, includes a smaller, similar version, possibly a precursor to the heavy plow. Comparable in shape, the Osterburken plowshare differs only in the worn symmetry of its coulter. Plowshares dating from Carolingian and Anglo-Saxon times were worn on one side indicating use of a moldboard that forced the plow to cut at an incline and create a furrow.

Changes in the rural environment occasioned by the end of the Roman Empire in the west led to the temporary abandonment of the heavier wheeled plow. Roman *latifundia* (landed estates) ceased to exist and villages were more scattered. As monarchical states formed

and monastic foundations settled wastelands, the rural population first stabilized then grew, larger fields were once again cultivated, and the heavier wheeled plow became desirable. The Benedictines were particularly important in promoting settled agriculture. Saint Benedict emphasized the virtues of manual labor, and many of his followers wore a pruning hook in their girdles symbolic of their agrarian labor. According to Benedictine tradition, Theodulf, from a monastery near Rheims, operated a plow daily for twenty-two years. After his death, his fellow monks venerated his plow at the church of Saint-Thierry.

Archaeological discoveries of plows from Poland, Bohemia, the Rhineland, and Savoy place the redevelopment of the heavy plow between the eighth and tenth centuries. While there is scattered earlier evidence from Cornwall and Wales, the heavy plow was not widely used across England and Wales until the eleventh century. Fossilized furrows from other parts of Europe support the idea of a gradual transformation in plow technology.

The heavy wheeled plowshare reduced manual labor by eliminating the need to cross plow and spade fields by hand. Its weight, coupled with the nature of the soil, demanded greater reliance upon animal power. The single team of oxen gave way to teams of eight or more and ultimately to teams of horses once the fixed wooden head collar was developed. Horses could work a field more rapidly than oxen, though they were more expensive to maintain. The Bayeux Tapestry shows a horse-drawn harrow, and its presence there may help explain the reluctance of English farmers to abandon the oxen for the horse.

While manual labor was saved, it hardly disappeared. An Anglo-Saxon plowman described his daily routine:

O my lord, I work very hard: I go out at dawn, driving the cattle to the field, and I yoke them to the plow. Nor is the weather so bad in winter that I dare to stay at home, for fear of my lord: but when the oxen are yoked, and the plowshare and coulter attached to the plow, I must plow one whole field a day, or more.

The plowman's fear was well-founded. He had to remain in the field as his tax was tied to the plowing he was expected to perform dur-

ing the year. The English plowland or hide came to be the unit of assessment, and eventually the day's plowing was standardized at an acre.

The new wheeled plow also improved drainage and increased crop yields. The moldboard turned the furrow to one side only, piling the soil to the center of the field and creating shallow trenches between plowlands. These trenches improved drainage. The better-drained fields ensured greater yields in wet and dry years. In wet years, crops flourished on the drier crest of each ridge, while in dry ones, crops grew in the furrows. Deeper plowing brought richer soil to the surface, also enhancing soil productivity. At a minimum, fields in France produced four times what had been customary in Charlemagne's time. Slowly, knowledge of marling and manuring became more widespread, and eventually farmers devised the three-field rotation with one field lying fallow every third year. As a result of these changes, all tied to the widespread adoption of the heavier wheeled plow, crops of wheat, rye, spelt, barley, and oats—staples of the European bread diet—rose dramatically across the continent.

Finally, the heavier wheeled plow altered field shape and necessitated agrarian cooperation. Cross plowing resulted in square Roman



Plowed field in which irrigation water fills the furrows between rows of plants.
(PhotoDisc)

field types; furrow plowing, especially with large teams of animals, was more suited to longer fields. As farms were divided into the lands of the lord and those of the tenant, field shape adapted to the new technology. The expense of a plow team forced most peasants to either share teams or borrow them from wealthier neighbors in exchange for labor. Thus, even tenurial relationships were revised by the plow as fewer tenants could maintain a purely independent status. Cooperation enhanced and stabilized community.

SIGNIFICANCE

The end result of the heavy wheeled plow was economic growth, a rise in population, the expansion of trade, and the growth of towns and cities. In a very real sense, the heavy wheeled plow nourished the feudal and religious establishments of medieval Europe.

Michael J. Galgano

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■ 8TH-15TH CENTURIES

HOHOKAM ADAPT AGRICULTURE TO ARID AMERICAN SOUTHWEST

The agriculture-based Hohokam adapted to a challenging desert environment, utilizing an innovative hydroagricultural economy. Their successful, productive economy allowed for a rich cultural apparatus, including sophisticated ceramics, stonework, and shell jewelry, in addition to features that mirror a Mexican stimulus: ball courts and pyramid mounds.

LOCALE: North American Southwest

AGRICULTURAL ISSUES: Archaeological discoveries; Drought; Ecology and environment; Hunting and gathering; Innovations; Irrigation and water management; Native American agriculture; Subsistence agriculture

SUMMARY OF EVENT

The Hohokam were an agriculture-based people who successfully adapted to a desert environment not suited for food cultivation. There exists no consensus among current archaeologists regarding Hohokam origins or the chronological sequence of development. Some scholars have suggested that the Hohokam were migrants from the south. In this model, the migrants displaced an earlier indigenous culture in the southwestern desert. Other fieldworkers interpret the Hohokam as being indigenous, and their roots are traced to an archaic hunting and gathering tradition that evolved into a sedentary agricultural society.

Pioneering archaeological work on the Hohokam began in 1888 when Frank Hamilton Cushing excavated at the Los Muertos and Los Guanacos sites in the Salt River Valley. In 1891, Cosmos Mindeleff worked at Casa Grande, a large Hohokam dwelling near the Gila River. A number of archaeologists, including J. W. Fewkes and Frederick Hodge, excavated numerous sites during the late nineteenth and early twentieth centuries, in an attempt to understand spatial distribution and cultural traits. Work at the large pueblo of Snaketown on the Gila River by Harold Gladwin and Emil Haury, among others,

began in 1934, with excavations continuing into the mid-1960's. In the twentieth century, archaeologists focused on varied aspects of Hohokam society and culture, including canal irrigation, ceramics manufacture, settlement pattern, chronology, and the diffusion of cultural traits from Mesoamerica, as well as the institutional framework of Hohokam society, which remains poorly understood.

Although debate persists over the chronological sequence, a general framework suggests that the Hohokam were farming in the river valleys by 300 B.C.E. By 300 C.E., significant changes were discernible in the cultural apparatus, which included sunken ball courts and earthen platform mounds. The large canal systems, essential for a successful agricultural rather than hunter-gatherer life, were well established by 700. Between 1250 and 1450 Hohokam occupation was greatly restricted, and it ultimately led to the abandonment of sites. In some cases, sites such as Snaketown were abandoned by 1200.

The Hohokam inhabited an area of about 45,000 square miles (120,000 square kilometers). Much of this region, including the Sonoran Desert, exhibits variability in elevation, hydrology, and vegetation. Summer temperatures regularly exceed 100 degrees, and annual rainfall for much of the region is often less than 12 inches (30 centimeters).

Within this region a great variety of flora and fauna supplemented an agricultural economy. Remains of prickly pear cactus, little barley grass, amaranth, and tansy mustard, among numerous other plants, have been recovered from Hohokam archaeological sites. Fauna that were hunted, trapped, and collected included rabbits, rodents, deer, and reptiles.

The primary subsistence strategies of the Hohokam, however, were agricultural and were linked to an irrigation technology. Among the crops produced, maize was the most important. Maize production began about 300 B.C.E. at the large community of Snaketown. Drought-resistant strains were probably developed and planted over a great period of time. Cotton was produced for its consumable seeds as well as for its fibers, which Hohokam weavers made into cloth. Beans of various types were cultivated, and varieties of domesticated squash were probably an important cultigen. However, very little evidence exists that attests to the cultivation of native plants. Also, domesticated livestock were unknown.



Arizona woman picking berries from a cactus—a plant long of great economic importance in the arid Southwest. (Library of Congress)

Canalization allowed for agriculture. By ensuring harvests in an environment prone to drought, the significant amount of labor required for food-gathering tasks could be channeled into producing a sophisticated material culture.

Hohokam waterworks channeled water from the rivers to individual fields. Canals could be quite extensive: Several near what is now Phoenix, Arizona, were ten miles (sixteen kilometers) in length. Some canals exceeded thirty miles (fifty kilometers) in length and crisscrossed the desert floor. Smaller branches directed water to individual fields. Canal gates that functioned to open and close off the flow of water were probably designed from woven grass mats. By 1200, Hohokam waterworks were very complex; some canals were up to thirty feet (nine meters) wide and ten feet (three meters) deep. Earthen dams on rivers directed water into the canals, and canal walls were occasionally lined with a clay mixture to prevent leakage. Construction incorporated a slight grade to facilitate water flow: The main canal at Snaketown dropped slightly more than five feet per mile (one meter per kilometer).

Domestic architecture consisted of pit houses, the primary domestic form through much of the Hohokam sequence. Houses averaged about twenty-six square yards (twenty-three square meters) in area and were about one foot (about one-third of a meter) deep. Poles were set in the ground and supported the roof, which was constructed of reeds or grass. Walls were designed from rush or reeds and slanted inward. A covering of earth completed the dwelling. Late in the Hohokam sequence (post-1300), large multistoried buildings such as Casa Grande were constructed. Casa Grande, about sixty miles (about thirty-seven kilometers) from Phoenix, Arizona, measured about forty by sixty feet (about twelve by eighteen meters). The adobe walls were four feet (slightly more than one meter) thick at ground level.

The Hohokam funerary complex centered around cremation. After a body was burned, ashes and bones were gathered and buried in a ceramic vessel. There is little evidence from funerary practices to infer evolving status or social rank.



Early twentieth century Tewa woman winnowing grain by her Pueblo home. (Library of Congress)

Villages of the period around the year 600 were small, probably never exceeding two hundred individuals. Snaketown may have held a maximum population of two thousand people by the end of the period (twelfth century). Hohokam architecture included raised earthen platforms and ball courts. One platform at Snaketown measured twenty-six yards long by twenty-one yards wide and nearly three yards high (twenty-nine meters long by twenty-three meters wide and about three meters high). Presumably community-wide ceremonial activities occurred atop these low earthen mounds. Ball courts were sunken with raised walls. These were oval depressions constructed in the ground about fifty-five yards long (about fifty meters) with sloping walls about 3.5 to 5.5 yards high (about three to five meters) on each side. The presence of ball courts has led archaeologists to suggest cultural diffusion from Mexico. The Mesoamerican ball game, or a variant, may have been played in these courts.

Ceramic technology included a number of different decorative patterns and motifs such as plain red ware, red on gray, and red on buff. Vessel shapes included animal and human effigy forms, plates, jars, and bowls of different sizes.

Hohokam stonework was extraordinarily sophisticated. Examples included effigy forms, a range of animals and birds, tools, metates (grinding stones) used in food processing, polished stone vessels, and stone palettes.

The Hohokam shell industry produced exquisite items and demonstrated a high level of specialization. Bracelets, rings, necklaces, and acid-etched shell were produced from a variety of shell species, most of which came from the Gulf of California.

SIGNIFICANCE

In fifteen hundred years of residency in the Sonoran Desert and river valleys, the Hohokam achieved a remarkable adaptation to a difficult if not unfriendly environment. Their agricultural engineering skills permitted the creation of a delicate and sophisticated material culture. The reality of their engineering achievements becomes increasingly remarkable when compared to other preindustrial cultures, especially as the Hohokam lacked the wheel, draft animals, and metals such as bronze or iron.

The Hohokam most likely were products of significant amounts of

cultural diffusion from central and northern Mexico over a great period of time. The demand for exotic bird plumage, the plant complex, ear spools, effigy vessels, copper bells, and artistic motifs, in addition to civic architecture, suggests powerful southern contacts. However, the centralized political administration that was necessary for various projects utilizing controlled labor in Mexico appears not to be a feature of Hohokam society. Family units and loosely coordinated groups of farmers could have provided the necessary labor for the construction and maintenance of the great waterworks systems. No evidence exists for a developed bureaucratic class among the Hohokam. This fact makes the Hohokam achievement even more unique.

Rene M. Descartes

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■ c. 800-1350

MISSISSIPPIAN MOUND-BUILDERS' AGRICULTURAL CULTURE FLOURISHES

Mississippian culture, the last and most advanced of the agriculture-based mound-building cultures, made up the final and most advanced stage of the prehistoric Late Woodlands peoples, who originated in the eastern part of North America.

LOCALE: Lower Mississippi, Southeast, and upper midwestern North America

AGRICULTURAL ISSUES: Hunting and gathering; Marketing and trade; Native American agriculture; Subsistence agriculture;

SUMMARY OF EVENT

“Mississippian culture” is a term denoting the late period of Native American prehistory and an advanced stage of indigenous cultural development in North America. “Mississippian” is the name used to describe the new era because the initial area of development was largely centered along the Mississippi River between modern St. Louis and Vicksburg and later along tributary streams in the Southeast, such as the Cumberland and Tennessee rivers.

Earlier mound-building cultures, such as the Adena (which flourished c. 800 B.C.E.-200 C.E.) and the Hopewell (c. 300-700), were noted for their permanent village settlements, their impressive earthwork constructions (including burial and effigy mounds), their inter-regional trade networks, their high-quality craftwork, and (by around 500 B.C.E.), some agricultural activity. While sharing these traits, Mississippian societies were, by contrast, predominantly agricultural. Moreover, they were organized into centralized political entities called chiefdoms. They were governed by elites in large population centers that contained larger and more complex monumental constructions than those of preceding eras. A trend toward increased territoriality and warfare also developed among Mississippian peoples.

Factors contributing to the rise of the Mississippian culture include the introduction of the bow and arrow (during the late



Late nineteenth century artist's depiction of a mound-builder community gathering corn and other crops. Several mounds can be seen in the background. (Library of Congress)

Hopewell period), the flint hoe, and a hardy variety of maize known as eastern flint corn. The latter was resistant to cold weather and had a shorter growing season. In the three to four centuries following 800, food production dramatically expanded as a result of intensive cultivation along rich bottomlands and other fertile areas connected to population centers by both water and land routes. Maize, which had originated in Central America, was a more productive and more easily stored crop than the native plant foods cultivated by the earlier Hopewell peoples and therefore spurred population growth. By 1200, maize, beans, and squash formed the basis of the diet, supplemented by hunting, fishing, and gathering.

Mississippian peoples shared a number of features with the high civilizations of Mesoamerica. In addition, the Mississippians probably traded, and to some degree intermingled, with Mesoamerican peoples. Nevertheless, some scholars see the impact of Mesoamerican cultures on the Mississippian as minimal and stress the largely independent development of Mississippian culture.

MOUND-BUILDING AREAS



The period of the Mississippians' initial growth witnessed the rise of some spectacular ceremonial centers and even true urban complexes, with wattle-and-daub, rectangular buildings. These were centers of political, social, religious, and economic power, as well as a rich artistic ceremonial life, fortified by log palisades and containing residences, public buildings, and elevated central plazas with great temple mounds topped by shrines and dwellings for rulers and other elite members of society. Subordinate and outlying settlements paid tribute to the noble elites in these centers.

Mississippian society was stratified and dominated by an elite class from whose ranks came all-powerful male and female hereditary, theocratic rulers known as Great Suns. These exalted leaders, who

may have been revered as deities or representatives of deities, were richly adorned and surrounded with great ceremony. Priestly religions oriented toward agriculture exercised a powerful and central role in maintaining this social, economic, and political order. Many anthropologists believe that the elite lineages and mound-building centers arose in locales best suited to producing a reliable supply of food and strategically placed for trade, which in turn served to secure political allies who occupied less favorable locations.

For many centuries, the heart of the Mississippian civilization was the great city of Cahokia, located about eight miles (thirteen kilometers) east of modern St. Louis on the fertile Mississippi floodplain. Established as early as the eighth or ninth century, the city reached its peak of influence between 900 and 1150. The largest prehistoric metropolis north of Mexico, Cahokia (also called City of the Sun because Sun symbols, Sun calendars, and indications of Sun worship have been unearthed there) occupied an area of five square miles (thirteen square kilometers) and at its height was home to a population of twenty thousand or more people, according to some estimates. Thousands more lived in small, "suburban" settlements and farmsteads.

Cahokia contained more than one hundred ceremonial mounds. The largest and most spectacular earthwork, Monk's Mound, towered over the city's central plaza. The earthen base of this monumental construction is larger than those of the largest pyramids of Egypt and Mexico, measuring 1,100 by 790 feet (335 by 240 meters) and covering 16 acres (6.5 hectares), with a total volume of 804,608 cubic yards (618,929 cubic meters). The top tier served as a platform for a large temple and residence of Cahokia's priestly ruler. Surrounding this ceremonial area was a timber palisade, which extended for more than 2 miles (3 kilometers). Nearby, builders also laid out an observation area with wooden poles placed in a circle. This structure, later known as Woodhenge, was probably used to keep track of the movements of the sun and other heavenly bodies.

Cahokia's strategic location near the Mississippi River and its junctures with major tributary river systems made it a great commercial hub of the continent during the tenth, eleventh, and twelfth centuries. Dugout canoes laden with highly valued trade items arrived from both local and distant waterways. Mississippian craftspeople ob-

tained products such as obsidian from distant mountain areas of the American West, copper from the Great Lakes, mica from the Appalachians, seashells from the Gulf coast, quartz from Arkansas, and silver from southern Canada. Using these and local materials, Mississippian artisans produced ornaments and jewelry, a unique pottery tempered with crushed mussel shells, effigy jars, cult figurines in human and animal form, ceremonial costumes, and items made from feathers, leather, stone fibers, wood, and beaten copper.

In addition to Cahokia, Mississippian civilization gave rise to other notable population centers and small chiefdoms. Some have been excavated, including Moundville in Alabama, Etowah and Okmulgee in Georgia, and Spiro on the Arkansas River in eastern Oklahoma. Although all were considerably smaller than Cahokia in both territory and population, they nevertheless were active and thriving centers of population, craft production, and a rich artistic and ceremonial life.

Neighboring regions of the Midwest, including sites in the Great Lakes area and the Ohio Valley, have been linked to the Mississippian cultural complex. Migrations of Mississippian peoples from the Southeast also brought new groups westward into the Great Plains, where they established agricultural villages in favorable areas along major streams and gave rise to a Plains Mississippian culture.

The power of the various southeastern chiefdoms and regional centers ebbed and flowed. A period of decline occurred after 1350, prior to the arrival of the Spaniards. The great mound-building projects ceased, and the major centers gradually disappeared. Rivalries and power struggles, as evidenced by an increase in fortifications, weaponry, and a glorification of the warrior in religious art, may have been part of several factors contributing to this decline. An exception was the Natchez chiefdom, which survived in pristine Mississippian form until its destruction at the hands of the French and their local native allies during the early eighteenth century. IncurSIONS of European explorers and gold seekers into the Southeast during the early sixteenth century brought new pressures, especially the fatal epidemic diseases against which the indigenous populations had no immunity. The result was a precipitous decline in the Mississippian population from millions of people to a few hundred thousand.

SIGNIFICANCE

Many tribal cultures of the historic southeastern United States retained Mississippian traditions after the culture's decline. These groups include indigenous nations such as the Muskogee Creek, Choctaw, Chickasaw, Alabama, Cherokee, Shawnee, and Caddo. Remnants of the prehistoric culture survived in permanent agricultural settlements, a reverence for mounds as sacred symbols, strong matrilineal clans, some social stratification, the Green Corn ceremony (a purification ritual performed at harvesttime), and ball games such as "chunky," which was played with a rounded stone disk. The power of Mississippians on land and water, which impressed the Spaniard Hernando de Soto's expedition (1539-1542) to the Mississippi River area, delayed the European conquest of North America. Many of the aforementioned tribal nations retained their independence until as late as the early nineteenth century.

David A. Crain

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■ 9TH-14TH CENTURIES

SOUTHERN AFRICA'S TOUTSWE KINGDOM RISES ON AGROPASTORALISM

Archaeological evidence shows that the Toutswe Kingdom existed in a territory flanked by the Zambezi River in the north and the Limpopo River in the south, from approximately the early ninth century to the fourteenth century. Its economy was based on an agropastoral mix of scattered pastoralist and agricultural communities.

LOCALE: Southern Africa (now Botswana)

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Cattle keeping; Hunting and gathering; Marketing and trade

SUMMARY OF EVENT

The Toutswe culture of Southern Africa developed from a group of Bantu people whose language derived from the Sala-Shona branch of languages. The Bantu populations that came to be known by historians as the Toutswe seem to have inhabited lands also utilized by the Khwe (non-Bantu-speaking) populations of livestock-herding, wild-food-gathering peoples.

Archaeological excavations carried out by James Denbow demonstrate that early cattle raisers, who practiced many of the lifeways indistinguishable from the later Toutswe, began to settle Toutswe sites beginning in the seventh century. These sites are characterized by hilltop settlements, scattered homesteads, and evidence of cattle raising. The evidence indicates that the region occupied by the Toutswe state was previously occupied for several centuries by Bantu speakers, coinciding with the Iron Age developments that were occurring during the late first millennium in many regions of Africa.

The Toutswe economy was agropastoral, with a population inhabiting communities that were organized as scattered homesteads. These separated settlements probably were a response to sparse food sources and limited natural resources, which were unable to support denser settlements. The settlements were also typically located near

water sources—probably another reason that the homesteads were scattered.

The Kalahari Desert is believed to have served as one of the hunting grounds for the Toutswe people. The most important sources of meat for the Toutswe were domesticated cattle, sheep, and goats, but large bovids, such as the zebra, the eland, and the wildebeest, enhanced the main sources of meat for the Toutswe. Other sources of food were cultivated crops, such as millet, sorghum, nuts, and melons.

The headwaters of the Limpopo River served as the primary settlement grounds for the Toutswe. Here they settled in large hilltop communities in locations that offered security: Hilltops are easily defended against attacking enemies. Their settlements were arranged in a circle, and the buildings themselves were circular.

Large Toutswe settlements and villages have been identified by the presence of a grass, *Cenchrus ciliaris*, whose reflective properties make it easy to identify in aerial photographs. It is believed that these grasses thrive in the soil left by cattle in kraals (pens or enclosures), where the animals' dung has enriched the soil with nutrients especially favorable to the grass's growth. The grass thus became a marker



Cattle looking for fodder during one of the many droughts experienced in Botswana's Kalahari Desert region. (©Lucien Coman/Dreamstime.com)

for Toutswe settlements. The presence of *Cenchrus ciliaris* has also pointed to three main settlements—Toutswemogala (which means Toutswe Hill), Bosutswe, and Shoshong—at three main hilltop sites. Evidence suggests that these three dominant subkingdoms of the Toutswe existed by the twelfth century.

Each of the three main hilltop sites encompassed an area covering just over 1.5 square miles (more than 40,000 square meters). At these main hilltop sites, archaeologists have uncovered enormous dung deposits and remains of trade items from the Indian Ocean and elsewhere. The largest site, Toutswemogala, was occupied for approximately five hundred years and covers more than nearly 4 square miles (100,000 square meters).

Secondary sites covered an area half that of the three main hilltop sites. Typical of these sites are Mmadipudi, Thatswane, and Taukome, occupied for approximately two hundred to three hundred years. The kraal deposits of the secondary sites were large but not comparable in size or volume to that of the main site, Toutswemogala. Trade items have also been found at the secondary sites.

Yet smaller, tertiary sites include Maipethwane and Kgaswe, which range from about about 2,400 to 6,000 square yards (2,000 to 5,000 square meters) in area. The tertiary sites contain small kraals usually around 33 yards (30 meters) in diameter. Numerous ceramics and stone artifacts have been found at these tertiary sites.

There has been speculation of a fourth-level site, which arose from the finding of stone concentrations indicating that certain elements of the Toutswe milieu focused on hunting and gathering rather than herding and farming. The stone concentrations include stone tools and spears, used particularly for hunting. Whether these were Bantu or non-Bantu populations within the realm of Toutswe rule remains unknown.

Various organizational features distinguish the three tiers of the site: length of occupation, size of cattle kraals, proportion of exotic trade items, relative numbers of domestic stock, the area of land covered by houses, and additional variations in features of the settlement communities.

From the various sites and archaeological evidence, it is clear that the Toutswe Kingdom was a hierarchal society, consisting of three primary economic or social classes, determined by the quantity and

quality of cattle possessed. Cattle announced the class and wealth and were used for significant social and political transactions. Those with the most cattle occupied the top of the social hierarchy and lived on the hilltops in elaborate homesteads that were capable of housing hundreds of cattle. Local chiefs possessed fewer cattle and lived in smaller homesteads, typically 7,000 square meters (about 8,400 square yards) in size. At the bottom of the hierarchy were the majority of the Toutswe people. Their homesteads were approximately 1,000 square meters (836 square yards) in size, and they were fortunate if they possessed a small livestock pen. In some of the smaller hilltop villages and all of the capital towns, there were the essential large community cattle kraals.

The increase in trade across the Indian Ocean after the commencement of gold mining in the twelfth century greatly affected the value of cattle to the Toutswe culture. Although cattle retained their value as a food source, they began to decline as a form of wealth as surrounding states de-emphasized the value of cattle. With luxury items such as gold and imported foreign goods in circulation, cattle were no longer the most important means to gain social power and political importance. Higher-order Toutswe sites began to see a decline in the value of cattle, which in turn led to a reorganization of cattle herding. The cattle were shifted from core centers to lower-order communities as the higher-order classes began to accumulate other forms of wealth.

The Toutswe Kingdom came to an end between the thirteenth and fourteenth centuries. Although the reasons are unclear, the Toutswe people evidently moved elsewhere and abandoned their homesteads. Various explanations have been put forward: A drought may have caused the Toutswe to move eastward, or too many cattle may have caused a drain on resources and finances. The scattered hierarchical layout of the kingdom may have contributed to the demise of the Toutswe, as well. The greater population had continuously growing herds of cattle whose grazing was more than the land could support, evidenced in remains at Taukome, where the Toutswe often slaughtered juvenile and postreproductive animals to help control herd maintenance.

SIGNIFICANCE

The exact cause of Toutswe decline is unknown, but scholars hypothesize that severe environmental degradation from cattle raising, environmental shifts from desertification (expansion of the Kalahari), dissensions within the state, or a combination of these are the most likely causes of the collapse. Another distinct possibility is that Toutswe's decline was the result of the increasing power of Great Zimbabwe to the east. As resources were drawn toward Great Zimbabwe, neighboring states may have found it difficult to compete or maintain their established standards of living.

Toutswe was one of the few centralized states of interior Southern Africa. While there were many populations of nonsedentary hunter-gatherers in this region prior to the emergence of the Toutswe state, at the cusp of the first and second millennia, there is little material evidence of those populations. Thus the archaeological evidence on Toutswe sites provides important insights into the probable lifeways of earlier populations in the Botswana region of Southern Africa, including with which other communities the Toutswe may have had social or economic interactions.

Dwight Kieffer, David Lindsay, and Carol Olausen

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■ 9TH-15TH CENTURIES

NORTH AMERICAN PLAINS VILLAGE CULTURE FLOURISHES

The classic Plains Village culture of the eastern U.S. plains region developed permanent villages along river bluffs and was devoted to agriculture and gathering, supplemented by seasonal hunts.

LOCALE: Eastern plains, United States

AGRICULTURAL ISSUES: Archaeological discoveries; Hunting and gathering; Migration; Native American agriculture; Subsistence agriculture

SUMMARY OF EVENT

The classic image of the Native American—of the Indian on horseback hunting buffalo or fighting the U.S. Cavalry and living in circular tipi villages—is only true of a short period of Native American life, that of the High Plains Indian after the mid-nineteenth century. Indispensable to the High Plains period, the culmination of the Plains Village period that remained relatively unchanged until the nineteenth century, was the widespread and transformative introduction by Europeans of the horse and the rifle.

Inhabiting the Plains for more than seven hundred years, however, were the Plains Village Indians, who lived in the Great Plains region of what is now the United States, an area of about 1.5 million square miles (4 million square kilometers) from central Alberta and Saskatchewan (in Canada) to central Texas, between the Rocky Mountains and the Mississippi River. The area was mostly treeless grassland: short grass in the west and longer grass on the eastern prairies. There were wooded areas along the many river valleys. The high plains to the west had little rainfall and were very hot in the summer, which did not favor agriculture, but the prairies to the east received more rain and were more humid, a good climate for agriculture.

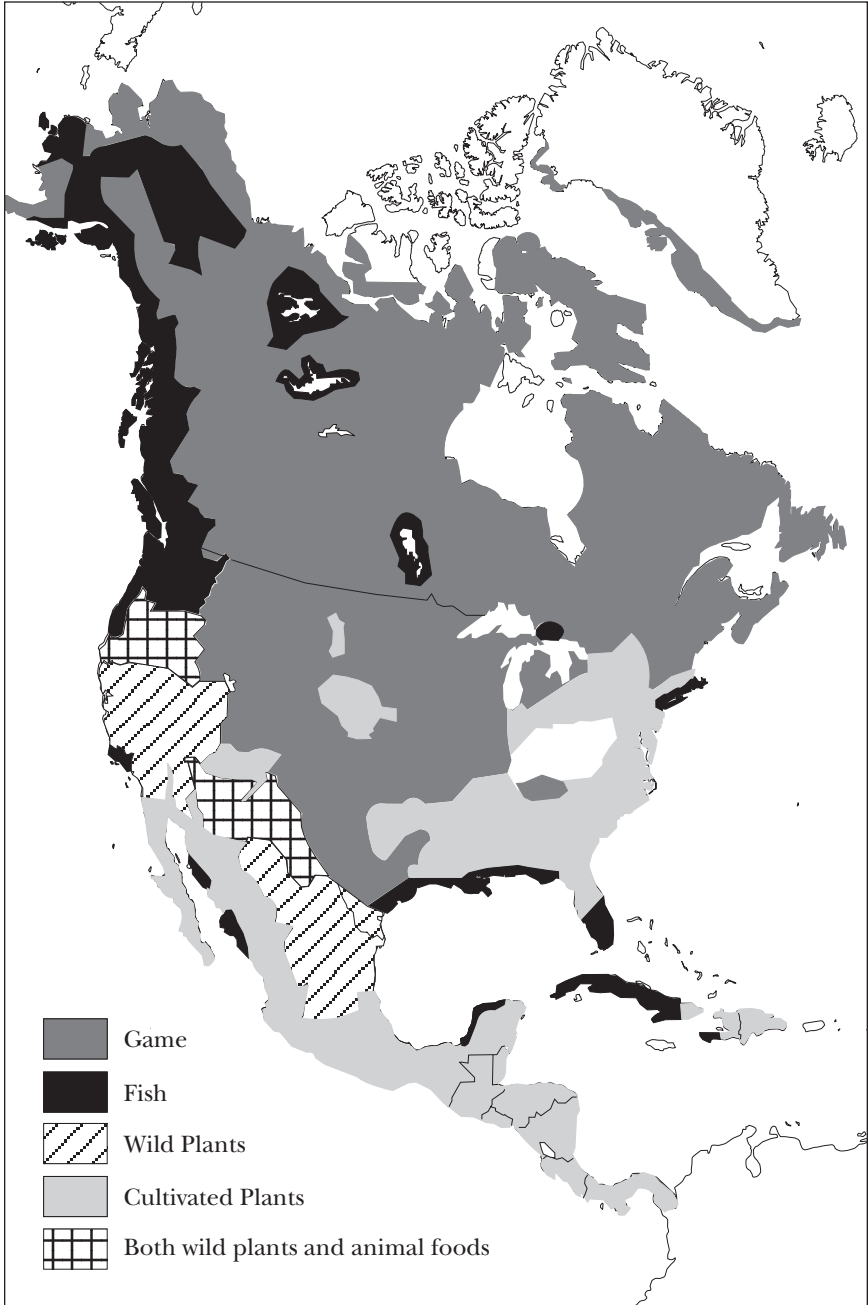
The first bands of nomadic hunter-gathers probably reached North America across the Bering Strait connecting Siberia with Alaska, probably about 18,000 B.C.E. As shown by evidence from the Folsom and

Clovis sites, by about 11,000 B.C.E., ancient peoples were hunting the huge now-extinct mammals (mammoth and bison) in the American Southwest. For a long period, the hot and dry high plains were largely deserted of people. The change from hunter-gatherer to farmer was gradual. By about 6000 B.C.E., groups on the eastern plains and in valleys along the Missouri and Mississippi rivers and tributaries began living in permanent villages to exploit fish and gather edible plants. Indians living on the Plains from about 500 B.C.E. to 1000 C.E. are called the Plains Woodland Indians. The principal archaeological sites are along the Missouri River and its tributaries, a main site being the Kansas City Hopewell site. Along the rivers of the eastern plains, from about 200 B.C.E. to 200 C.E., corn (maize), beans, and squash, and cultural influences including burial mounds and elongated pottery with cone-shaped bases, were introduced by farmers to the east.

As early as the ninth century, as agricultural efficiency improved, the Plains Woodland cultures changed into the Plains Village cultures on the eastern Plains. The Indians adopted a semisedentary lifestyle, living in permanent houses and small villages, with their subsistence divided between crops and hunting-gathering. Surviving parts of the villages are near fertile river floodplains. Village culture seems to have spread westward and northward, up the Missouri, Republican, Red, Arkansas, and Platte rivers and their tributaries. Initially, the settlements were scattered and only semipermanent, giving way eventually to larger permanent villages located on the bluffs and terraces overlooking river valleys. Farming took place on the river lowlands.

Unlike the mounds of the earlier Woodland and Mississippian cultures of the Midwest, or the cliff dwellings and pueblos of the southwestern Indians, the archaeological remains of the thousands of Plains Indians villages are now buried and barely noticeable along the river terraces and bluffs. Many sites are now buried by reservoirs created by later dam-building projects. What can be learned from archaeological evidence is supplemented or confirmed by observations and artifacts collected by anthropologists in the nineteenth and twentieth centuries. Archaeological evidence has led to the identification of numerous cultural areas, traditions, phases, and complexes.

PRIMARY SUBSISTENCE TYPES



Source: After Driver, Harold E., and William C. Massey, *Comparative Studies of North American Indians*, 1957.

Archaeological evidence for Plains Village dwellings consists of occasional stone wall foundations, major interior support post and smaller-wall pole holes (often filled with wood dust or charred wood), central hearths, cache pits, and refuse heaps. Burial remains have been found beneath house floors. This evidence indicates the villagers lived in domed, square, or rectangular multifamily lodges, up to sixty feet (eighteen meters) across, that could hold up to thirty or sometimes even fifty people. The lodges were covered with earth, grass, bark, mats, or hides, and entered by covered passages. Some tribes excavated the floor, so the lodges were partly subterranean. Many villages seem to have been laid out with no concern for defense. However, some villages in the Dakotas were fortified by ditches and pole stockades.

Stone artifacts found at house and village sites include arrowheads and spear points, knives, drills, reamers, scraping tools, elbow pipes, shaft abraders, and grinding tools. Artifacts made from bone include tips for digging-sticks and hoes, awls, beads, sickles, and fishhooks. Pottery shards, beads, and other ornaments are also common. Other more rarely found items include clay pipes, shell beads, and objects

*Late nineteenth century
northern Plains woman
blending traditional
techniques with European
implements to prepare a
meal. (Library of
Congress)*



made from obsidian and turquoise, indicative of trade with Indians of the Southwest.

Food was dried and stored in underground (cache) storage pits, and could remain edible for months. Corn was ground on stone metates. Agriculture was always risky: Crops could fail from too much or too little rain, high winds, storms, hail, grasshoppers, birds, and animals. Even if there was a good crop, there was always the danger of loss of stored food from rotting, rodents, or theft by other tribes when villagers were away on hunts. Trading was common, especially trading agricultural goods for products of the hunt, primarily buffalo hides.

The villagers also depended to varying degrees on hunting (the able-bodied members of the village took part in two hunts per year) and gathering, including the gathering of berries, fruits, and nuts. It appears, however, that cultivated crops remained the major source of food. The success of all these methods ensured the availability of food throughout the year.

Buffalo meat from the hunts was eaten fresh, dried and stored, or turned into pemmican, which could last four to five years. The buffalo hunt provided clothing, materials for shelter, and a variety of tools, containers, ropes, belts, spoons, and cups. Dried buffalo drop-pings made excellent fuel.

Plains Indian society was ranked and stratified, based on one's wealth or spiritual powers. Men could achieve status through deeds of bravery in war. The position of chief was often mostly honorific, and an individual held the authority as long as he commanded respect. Older men often formed councils, which led the tribe.

In their spiritual beliefs, the Plains Indians did not make sharp divisions between the sacred and the secular. They believed in the importance of visions (dreams), which were a way of connecting with the spirit world. Success in life depended upon the guidance of friendly spirits. Individuals held "vision quests" to beg for assistance, which were accompanied by self-inflicted deprivation or punishment. If the suppliant was successful, a spirit (often in the form of an animal or bird) would appear with instructions.

Tribes had medicine men, or shamans. With their supernatural powers, they were a bridge between the sacred and secular world, and could cure illness (although herbal remedies could be used for less

serious illness). Rituals and ceremonies varied among tribes, and some could last up to four days. Important ritual artifacts usually included sacred medicine bundles.

Early anthropologists estimated the entire Plains area population to be between 130,000 and 300,000 people. Recently, the population of all Indians on the Great Plains at about the year 1520 was estimated to be more than two million. Later reports by Europeans of the sparsely populated plains probably do not reflect the great reduction of the population by disease during that time.

Migration of groups in response to droughts and possibly hostile groups led to the demise of the Plains Village tradition. By 1400, the Plains Villagers on the eastern periphery of Nebraska and Iowa had departed, drought being one likely reason, and had been replaced by the Oneota people. Likewise, because of major droughts and an unpredictable climate, the areas along the western periphery of Nebraska, Kansas, and Colorado, and the Texas and Oklahoma panhandles, had been depopulated by 1400. By 1500, the southern plains of Texas and Oklahoma were abandoned and its peoples dispersed, again possibly because of poor climate. The Central Plains villages of Nebraska and Iowa had been abandoned by the mid-sixteenth century.

SIGNIFICANCE

An increasing reliance on agriculture and on bison hunting led to the full development of the Plains Village culture. Significantly, villagers slowly began living in large, permanent, self-sufficient locales and balanced agriculture with seasonal hunting trips, helping the stable and conservative culture to survive for almost seven hundred years. Plains Village culture might have survived and thrived indefinitely, except for the effects of climate change and the arrival of Europeans, which occurred in 1541 in Kansas with the explorations of the Spaniard Francisco Vázquez de Coronado.

Thomas McGeary

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■ AFTER 850

CHAN CHAN ADVANCES ANDEAN AGRICULTURAL TECHNOLOGY

Chan Chan, the capital of the Chimú Empire, ruled the north coast of Peru for several hundred years and established a political and economic administration later used by the Incas. It was the largest city of northern Peru in pre-Inca times, and it developed a high level of artistic achievement, urban planning, and agricultural technology.

LOCALE: Moche Valley on the north coast of Peru

AGRICULTURAL ISSUES: Archaeological discoveries; Government policy and regulation; Marketing and trade;

SUMMARY OF EVENT

The ruins of the Chimú city Chan Chan are located on the desert coastal plain of the Pacific at the mouth of the Moche River, about 330 miles (530 kilometers) northwest of Lima. The first king of the Chimú Empire began to build Chan Chan sometime after the fall of the Moche Empire (c. 850), but the city did not begin to flourish until about 1000.

There were four types of structures that reflected a caste-like social system, a system the Incas used as a model for their own civilization: royal palaces or *ciudadelas*, elite structures for the nobles, small irregularly agglutinated rooms for commoners, and basic living quarters for laborers brought into the city from other areas of the empire.

The ruins of the city cover fourteen square miles (thirty-six square kilometers) and are dominated by ten large, citadel-like enclosures called *ciudadelas*. The thirty-foot-high (nine-meter-high) adobe walls are six feet (two meters) wide at the base. Each is orientated on a north-south axis and arranged in roughly a rectangle around the center of the site. The *ciudadelas* vary in size, but all have a north section, a central section, and a *chanchón* or wing on the south. This wing was the living quarters of the servants and retainers. A narrow passage led from the one door in the north wall to an audience chamber, a series of courtyards, a reservoir, and a large number of storerooms.



Restoration work on Chan Chan's outside walls. (©Michael Zysman/Dreamstime.com)

There is a complicated pattern of narrow corridors, courtyards, U-shaped rooms called *audiencias* (administrative control points), and storerooms. For security reasons, wells and storerooms were in the most interior part of the structure. The storerooms held large quantities of goods and could be reached only by a series of corridors that passed by the *audiencias*. Open courtyards with benches along one, two, or three sides served as *audiencia* chambers.

Each *ciudadela* was a royal residence, an administrative center, and bureaucratic headquarters of the Chimú Empire. All *ciudadelas* contained a royal burial chamber. The Chimú used a system of split-inheritance, which meant the heir to the throne inherited only the position of ruler, not the wealth of the dead king. His wealth was left to other members of the royal family, who lived in the former king's *ciudadela* and preserved it as a shrine. The new king had to acquire his own wealth, usually by conquest, and build a new *ciudadela*.

Another form of structure at Chan Chan is the elite compound. There are thirty-five of them, each enclosed by an adobe wall with

only one door leading into a series of narrow corridors. The elite compounds vary in size, number of wells, and internal divisions, or arrangement of rooms. As with *ciudadelas*, elite compounds had open courtyards with benches, *audiencias*, wells, and storerooms. Elite compounds did not contain burial chambers.

The nobles who lived in the elite compounds controlled space and especially water, scarce commodities in an urban area. This control gave them status and power just below the king. They were responsible for the distribution of food and other goods and for supervising the labor, called *mit'a*, required of the commoners, who constructed the structures and irrigation canals of the Chimú Empire.

Adjacent to or near elite compounds were compounds for commoners called small irregularly agglutinated rooms (SIARs). Most of the SIAR compounds were concentrated in the south, west, and northwest sections of the city, but one was in the middle of the city and another along the east side. Both of them were small and isolated without apparent association with other structures and lacking easy access to a well. The centrally located SIAR unit was constructed on an artificial platform. The other SIAR units were associated with elite compounds, wells, or large adobe-walled enclosures thought to be cemeteries. All had easy access to a well. The units seemed to be organized into self-contained wards. Interior walls were less massive than the walls around the compound and showed signs of remodeling, apparently as needs changed.

Rooms within the SIAR included one or more kitchens, work and sleeping rooms, and storage rooms. The storerooms were very small and also held items used in the manufacturing of goods; little food was stored in the SIARs. The inhabitants had to have supplies provided them on a regular basis. Redistribution of goods was a responsibility of the government and was administered by the bureaucracy. All supplies probably came from storerooms in the elite compounds. Refuse was piled in interior rooms or in the alleys between compounds. Over time, as the refuse collected, the ground level in the SIAR rooms and alleys became higher.

SIAR units served as residences for the lower class and were workshops for metalworking, weaving, and woodworking. The quality of the goods, especially gold work, was very high. In some units, llamas

and guinea pigs were kept as part of the food supply. The dung was tamped down to form the floor.

Basic housing was provided for a few outsiders, who lived in communal barracks-like buildings constructed by *mit'a* labor. One of these buildings was located in the southeast corner and the other near the center of the city, in what seems to have been an area set aside for trading. The building had direct access to the main route leading into the center of the city. A group of traders lived in the central building. The other outsiders were probably laborers brought in from the countryside to work on construction projects.

Chan Chan was the center of the political and economic system of the Chimú Empire. The king, the chief political and religious leader, was isolated from the masses in his *ciudadela* and appeared in public only on special occasions. The nobles who lived in elite compounds were the bureaucrats who administered the king's business. Control of water, food, space, and conscript labor was the basis of their power.

The Chimú believed in supernatural gods who could become visible to the faithful and be persuaded to help humans who asked for help, but only if the individuals would abstain from salt and pepper and from sexual relations.

Chan Chan controlled three administrative cities located in strategic areas of the empire, which extended at the height of its power from northern Peru to Lima but did not extend into the mountains. The administrative centers directed agricultural production and maintained and constructed new irrigation canals. They stored food until it was moved to Chan Chan.

Trade between the various areas of the empire provided a variety of both raw materials and manufactured products. Trade with areas outside the empire was not an important part of the general economy, but it did provide mostly luxury goods for the royal family and the nobles.

The Chimú successfully resisted conquest by the Incas until 1465, when Chan Chan finally fell. The king of the Chimú was taken to Cuzco and treated with great honor. His son then governed the Chimú territory as a puppet of the Incas. The city was abandoned shortly after its conquest, perhaps as a result of destruction caused by heavy battering rams.

SIGNIFICANCE

Chan Chan was the capital of the largest empire that existed before the Inca. It was the seat of an extensive bureaucracy that efficiently controlled a large population and the economy of all the territory of northern Peru. The Incas later copied the Chimú administration, the conscript labor system, the caste-like social structure, and the incorporation of conquered territories into the empire. The economy, based on agriculture, was made possible by the extensive irrigation canal network. The Incas also copied the excellent metalworking and weaving of the Chimú.

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■ C. 1000

FAILED AGRICULTURE SPURS HUARI AND TIWANAKU COLLAPSE

The two major highland states of the high Andes collapsed around the year 1000. Intense conflict signaled the end of Huari, whereas a combination of environmental and social factors appeared to signal the fall of Tiwanaku. The reasons for this collapse are debated but may have had to do with the failure of the states' agricultural systems.

LOCALE: Highlands of central and southern Peru, western Bolivia, and northern Chile

AGRICULTURAL ISSUES: Archaeological discoveries; Drought; Ecology and environment; Subsistence agriculture

SUMMARY OF EVENT

Around the year 500, two large polities dominated the Andean highlands: Huari (also called Wari), with its homeland in the Ayacucho basin of central Peru, and Tiwanaku (also called Tiahuanaco), in the Lake Titicaca basin of western Bolivia and southeastern Peru. Although these contemporaries had some contact and shared a number of affinities in artifact style and motif, they appear to have developed independently in their homelands.

The Huari were an expansionist people, and at the height of their power they controlled most of the Andean sierra, ranging to Cajamarca in northern Peru to the Cuzco basin in the south. They also had significant contact with coastal Peru. The capital of the Huari state was at the eponymous site of Huari, which was well in excess of 1.5 square miles (4 square kilometers) in size and had a maximum population ranging from ten thousand to seventy thousand. This center was supported by a massive irrigation and terracing system. Water was brought to the site by canals from a series of high-elevation springs and streams and was then distributed to hillside terraces into the agricultural fields. Maize was the principal crop, but it was supplemented by Andean domesticates, such as quinoa and various tubers.

Huari expansion was accomplished through a variety of means,

but military conquest and domination appear to have been the most important strategy. However, Huari administration of the areas within their domain varied considerably depending on what the Huari wanted from the conquered polity and its degree of political complexity. In the highland valleys relatively close to Huari, for example, it appears that the Huari forced local populations to move their settlements to somewhat lower elevations into fertile areas suitable for growing maize. The terraces of these valleys were expanded considerably, and it is likely that the Huari imported labor from elsewhere to assist in this effort. Finally, they constructed enclosures in Huari architectural style. The function of these enclosures is uncertain, but they may have served as residences for Huari administrators, as storehouses, or both.

In more distant areas, the Huari used different strategies. Instead of intervening directly in agricultural production, they concerned themselves with the extraction of prestigious goods, such as fine ceramics, metals, textiles, and marine shells. The Huari built administrative centers according to a strict architectural canon at more than thirty locations in the Andean sierra. Significantly, none of these centers showed evidence of fortifications.

The evidence on how Huari collapsed is scant, but most signs point to imperial overextension and increased conflict. The consumption of prestigious goods in the Huari core grew substantially over time, and this forced distant Huari administrators to extract ever more production from their subjects. As demands grew, probably so too did resistance, and some have argued that subject peoples resorted to violence to overthrow the Huari. Evidence for the increased level of warfare around the year 1000 suggests this scenario is highly plausible. It is also possible that agricultural production in the Huari core was unable to keep up with rapid rates of population growth, and this probably led to instability and conflict in the homeland itself.

Tiwanaku emerged under very different circumstances. The Tiwanaku heartland and the site itself are found on the high Altiplano just to the east of Lake Titicaca at an elevation of more than 12,500 feet (3,810 meters) above sea level. Although cold and windswept, the environment is highly productive. Tiwanaku subsistence practice focused on a combination of resources and agricultural technologies,



Modern terraced farms along the shores of Lake Titicaca. (Clyde L. Rasmussen)

including raised fields, rain-fed fields, camelid herding, and lake exploitation. Raised fields were especially important; in the Andean highlands, they were used where land was prone to significant flooding or was otherwise waterlogged. They have been shown to improve soil condition, trap nutrients, and improve microclimates by minimizing the risk of frost damage to crops. However, they needed large amounts of water to function effectively, and so the Tiwanaku built an extensive canal system to maintain them, requiring a substantial investment of labor for their construction and maintenance.

Tiwanaku is relatively large, about 2.5 square miles (6.5 square kilometers) in size, and composed of residential areas, platform mounds, and large sunken courts, which were the scenes of important rituals. The layout of roads and streets shows the site was carefully planned, and at its zenith, it was one of the largest urban centers in the Americas.

Tiwanaku conquered or annexed much of the southern highlands but at a relatively slow pace. Aside from its core in the Lake Titicaca basin, Tiwanaku did not control large, contiguous blocks of territory. Instead, they established trade relationships with neighbors or far-flung polities or created colonial enclaves in locations with key

economic resources or high agricultural potential. The area around what is now called Cochabamba in Bolivia was one such colony, as was the Omo site in southern Peru on the western flanks of the Andes. However, they also conquered smaller polities, especially in the lake basin, as is evidenced by the trophy head iconography of the large sunken court ritual center at Tiwanaku called the Akapana. Rituals and feasting were also important ways by which Tiwanaku elites maintained their power and convinced or coerced others to submit to their control.

There is clear evidence that c. 900 the Tiwanaku Empire began a steady decline. The Omo colony was destroyed by conflict, but it is not clear whether it was destroyed by a rebellion or by outside forces. Colonies in northern Chile were abandoned as well, and trade relationships also contracted.

The cause of this decline remains hotly debated. Some authorities have argued that the immediate cause of the Tiwanaku collapse was a long drought that began around 1000. A persistent and intense drought would have made raised field farming untenable, and if these fields were in fact the most important part of the subsistence agricultural system, the Tiwanaku elite would have been unable to maintain themselves and their people. However important the drought might have been as a cause of the Tiwanaku collapse, it is clear that it cannot be the only cause, because Tiwanaku's fortunes started declining well before the drought's onset. If this is the case, it suggests that politics, not environmental change, led to this collapse. What sort of political process may have occurred is uncertain, but there is no evidence of widespread violence, nor is there a sense that epidemic disease or hunger was a contributing factor. However, the drought after 1000 certainly hastened Tiwanaku's fall. By 1100, Tiwanaku had been abandoned, as were all of the other large Tiwanaku centers, and the population of the basin was dispersed into much smaller towns and villages.

SIGNIFICANCE

The collapse of these two highland empires created something of a power vacuum in the Andean highlands. Although coastal states continued to thrive and grow, in both the Huari and Tiwanaku homelands the collapse of political centralization led to the creation of

large numbers of small polities that engaged in constant warfare with one another. In Tiwanaku's former domain, this led to population movements as some groups tried to move away from the violence. Others built large hilltop fortresses that served as refuges when enemies appeared. This situation of small-scale, endemic warfare persisted in the Andean highlands for the next three hundred years until the Inca expanded out of their homeland in the Cuzco basin and created the largest empire in the ancient Americas.

Mark Aldenderfer

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■ 11TH-12TH CENTURIES

NORSE INTRODUCE FARMING TO GREENLAND

As Thule Inuit culture spread eastward across the Arctic and as Norse settlers established themselves in Greenland, Native Americans for the first time met, traded, and then clashed with Europeans.

LOCALE: Kalaallit Nunaat, in Greenland, and Vinland (now Atlantic coastline of eastern and northeastern Canada)

AGRICULTURAL ISSUES: Archaeological discoveries; Climate change; Hunting and gathering; Marketing and trade; Migration; Native American agriculture

KEY FIGURES

Erik the Red (c. 950-1001?), founder of Norse settlement in Greenland
Leif Eriksson (c. 970-c. 1035), son of Erik the Red, first European discoverer of Vinland

Thorvald Eriksson (d. c. 1004), brother of Leif, first Norse casualty at Vinland

Thorfinn Karlsefni (c. 980-after 1007), leader of a colonizing expedition to Vinland

SUMMARY OF EVENT

In the latter part of the first millennium, Neo-Eskimos, or Inuit, as they called themselves, spread rapidly from northern Alaska across the Arctic to Greenland. Innovative Thule culture Inuit were much better adapted to Arctic conditions than their Dorset culture predecessors. Dorset Inuit depended on heavy spears when hunting and hand-pulled their sleds. Thule Inuit developed one form of the bow and arrow and various sizes of stone-pointed harpoons, and they had dogs pull their sleds. To pursue large whales in open waters, Thule Inuit created umiaks, open skin boats holding a crew of eight, and used one-person kayaks to hunt smaller sea mammals that also were pursued by the Dorset.

Use of kayaks and umiaks in summer and dog sleds in winter per-

Early twentieth century Inuit seal hunter, whose ancestors used similar hunting gear. Among the most important things Europeans introduced to the Inuit were metal tools and weapons that made it easier to kill and process animals. (Library of Congress)



mitted Inuit hunters to travel rapidly. Taking advantage of climatic warming from the ninth to the twelfth century that provided open water in the Arctic, Thule Inuit followed whales across the northern coast of Canada, probably reaching northwest Greenland around 1000.

Greenland is the world's largest island, but only one-sixth of its surface is open land. Most of its terrain is covered by an enormous ice cap, thousands of feet deep, with many associated glaciers. The only ice-free areas are along the mountainous coasts. Smaller islands are numerous, and long fjords run far inland. The Inuit preferred to locate on the headlands, islands, and sea ice outside the fjords. Whales, seals, and other marine animals abounded there, providing food and clothing. Caribou hunts drew the Inuit inland during warm weather,

but they distrusted the fjords, where even in winter the ice was treacherous. Moving south along the west coast, the Thule Inuit met another group of migrants who had arrived in Greenland at approximately the same time.

Erik the Red (Erik Thorvaldson) was the first Norseman to explore Greenland. Born in Norway, he had come to Iceland as a teenager when his father was exiled for manslaughter. Erik himself was banished from Iceland for three years in 982 for a similar crime and decided to sail west and explore land sighted earlier by a ship driven off course in a storm. Unable to approach the forbidding east coast of Greenland, Erik sailed around the southern tip of the island and discovered deep fjords with lush grass meadows at their head. Erik selected for settlement an area of southwest Greenland in which the ice cap is more than 100 miles (161 kilometers) from the coast and the climate is less harsh than elsewhere on the island. It was the only part of the island where farming was possible. During the three years that Erik and his party explored the west coast, they met no other people, though they did find evidence of previous occupants, probably Dorset Inuit.

Erik's description of the island he named Greenland to stress its attractions excited land-hungry Icelanders. When he sailed back to Greenland in 986, Erik led twenty-five ships. Fourteen vessels carrying some four hundred people arrived and created an eastern settlement in today's Julianehåb area (Qaqortoq). By 1003, three other immigrant fleets had landed, bringing the population to about one thousand and establishing a western settlement in today's Godthåb area (Nuuk, the capital of Greenland).

Most of those who came were farmers seeking good grazing land for their cattle and sheep. The grassy meadows along the fjords suited the type of agriculture the settlers had practiced in Iceland. From their animals, they produced meat, milk, cheese, and butter in large quantities. To these products they added fish, along with seals, walrus, and caribou collected on annual hunts in northern Greenland. The growing season was too short for wheat, and bread was practically unknown. Trade with Norway provided badly needed timber, iron, weapons, and clothing of European style. In exchange, the settlers sent furs and hides, walrus ivory, white falcons, and much-admired polar bear skins. During the colony's peak population of more than four thousand in

the thirteenth century, the eastern settlement contained 250 fifty farms, supporting twelve parish churches, an Augustinian monastery, a Benedictine nunnery, and a cathedral at Gardar (now Igaliko). The smaller western settlement had ninety farms and four churches.

Norse exploring and hunting voyages ranged north along the Greenland coast and westward to the North American continent. The first contact between Native Americans and Norse, recorded in the Norse sagas, occurred on the coast of North America. In 1001, Leif Eriksson (also called Leif the Lucky) sailed for Greenland but instead sailed off course and reached the land he named Vinland the Good, the Atlantic coast of what is now eastern and northeastern Canada. His brother Thorvald, continuing Leif's exploration a few years later, met a party of nine native people and immediately attacked them, killing eight. A counterattack by a larger number of native people caused Thorvald's death from an arrow wound. Who these people were is unclear—the Norse applied the contemptuous term *Skraelings* (possibly meaning “weak” or “sickly”) to both Inuit and North American Indians. The attackers may have been Thule Inuit moving down the coast in pursuit of sea mammals or Algonquian-speaking Indians. In either case, the encounter was predictive of the violence that would mar future Native American-European relations. An attempt to colonize Vinland, led by Thorfinn Karlsefni, enacted a similar history. Although peaceful trading marked his group's first encounter with *Skraelings*, attacks by the local people soon forced abandonment of the settlement.

Around 1500, the Norse disappeared, while the Thule Inuit became the ancestors of the present Greenland population. When the climate turned colder after 1200, during a period of global cooling known as the Little Ice Age, conditions worsened for the Norse. Increasing drift ice along the west coast of Greenland limited the ability of Norsemen to hunt sea mammals. Despite several centuries of contact with the Inuit, the Norse never adopted the superior Arctic hunting techniques of the Thule. Shorter growing seasons meant that grassy meadows no longer supported as many grazing animals as before. Archaeologists note that later graves are shallower than earlier ones, reflecting the difficulty of digging in the frozen ground. Problems in Norway—the black plague and political turmoil—distracted Norwegians and caused abandonment of trade with Greenland.

As the ice moved south, the Inuit followed in larger numbers. Their animal-skin-covered boats and their dog sleds and fur clothing perfectly adapted to the colder climate.

SIGNIFICANCE

Not all encounters between native people and Europeans were violent. Both Inuit legends and Norse sagas describe friendly meetings and trade between the two peoples. Within fifty years of their arrival on Greenland, Norse hunting parties, ranging north, came upon Thule Inuit. Archaeologists find many Norse objects in Neo-Eskimo sites; some might have resulted from raids or may represent loot from abandoned Norse areas, but many most likely came from trade. The quantity of walrus tusks and skins exported to Norway appears too large to come solely from Norse hunts and probably included additions from trading with the Inuit. Possibly the two peoples could have coexisted peacefully in Greenland as the Inuit concentrated on the coast and the Norse preferred interior fjords. Most Norse references to Skraelings, however, describe conflicts, and the main theme of Inuit legends about the Norse is how Norsemen were met and conquered.

What ultimately happened to the Norse is not clear from surviving sources. The Inuit may have wiped them out, or, as the climate worsened, the less well-adapted Europeans may have slowly declined in number and died off. Possibly the Norse used their boats to retreat to Iceland or Norway. Some scholars have suggested that the survivors may have joined the English or the Portuguese who became active in North American waters at the end of the fifteenth century. Whatever the reason, the Norse vanished, and Greenland's future belonged to the Inuit.

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RICE CULTIVATION IS INTRODUCED TO CHINA

Trade from Southeast Asia brought rice to China, where it became such an important staple crop that the Chinese word for “rice” became virtually synonymous with the word for “food,” and China would lead the world in rice production into the twenty-first century.

LOCALE: China

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Drought; Marketing and trade; New crops and food products

KEY FIGURE

Zhenzong (Chen-tsung, 968-1022), Song Dynasty emperor, r. 998-1022, who ordered short-season rice imported from Champa to alleviate a famine

SUMMARY OF EVENT

Rice is a cereal grain adapted to life in wetlands. It probably evolved in response to the monsoon cycles of Southeast Asia (modern Vietnam, Laos, Cambodia, and Myanmar). Most scientists believe that the original plant species from which domesticated rice developed is now extinct and that the present cultivated varieties arose from it through a process of progressive evolution over several thousand years, speeded by selective propagation by humans. The scientific name of domesticated rice is *Oryza sativa*.

Various primitive types of rice have been cultivated in southern China from prehistorical times. In even the earliest forms of the written language, agriculture is synonymous with the cultivation of rice. This correspondence of terms indicates that rice was already the principal crop of the region as early as the Shang Dynasty (1600-1066 B.C.E.). Rice was so important that a myth arose regarding its discovery after a worldwide flood, a discovery that ended the famine that followed the flood. By contrast, European food myths such as those of Ceres or Demeter deal with the discovery of wheat, Egyptian food

myths center on barley, and Mesoamerican myths, including those of the Aztec and Maya, deal with maize. The rice cultivated in early China was a relatively primitive strain that took 180 days, effectively the entire growing season, to mature to the point that it could be harvested.

This situation changed in the first part of the eleventh century, with the introduction of new strains of early-ripening rice from Champa (modern Cambodia and central Vietnam). In 1012, following a severe drought on the lower Yangtze and Huai rivers, the Song emperor Zhenzong issued a proclamation ordering thirty thousand bushels of these Champa seeds to be shipped to the affected area, particularly Fujian Province. As the local peasants were unfamiliar with the new variety of rice, the emperor also commanded that pamphlets be printed and distributed throughout the area, instructing them on the virtues of the new form of rice.

According to the local histories of Zhejiang and southern Jiangsu Provinces, the use of Champa rice shortened the ripening time to less than a hundred days, although later selective breeding and hybridization reduced the growing cycle to a mere sixty days by the twelfth century. As a result, farmers were able to grow two crops instead of one every year, making every acre of cultivated land doubly productive. In addition to growing more rapidly, Champa rice required less water than did earlier varieties. Not only did this feature make Champa rice



Chinese black rice. (©Yali Shi/Dreamstime.com)

more resistant to drought, but it also enabled farmers to expand the cultivation of rice from the bottomland immediately beside the rivers. Higher ground and even hillsides could be planted in Champa rice and be relied on to produce a crop.

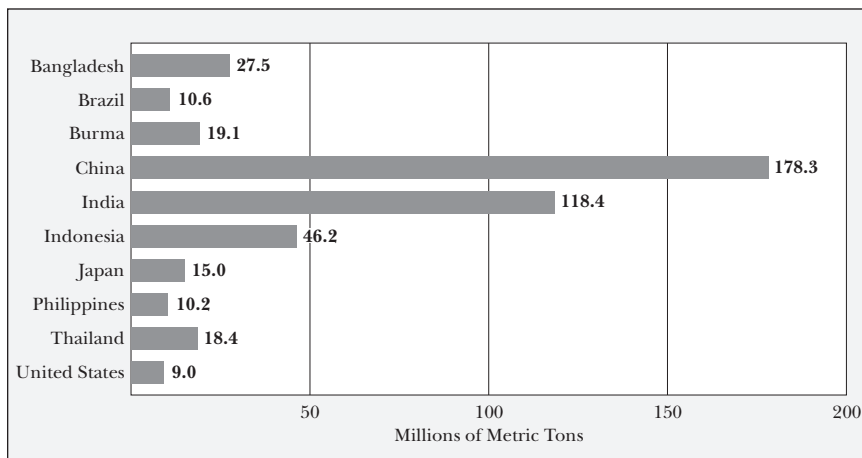
However, Champa rice was not entirely without its negative features. Because of its lower gluten content, it was less tasty and did not store as well as traditional varieties of rice. As a result, imperial taxes and levies continued to be collected on medium-gluten rice varieties.

During this period, the Chinese developed a method of rice farming that enabled them to squeeze every possible day out of the growing season. In sharp contrast to the methods used in planting almost every other grain known to humanity, Chinese peasants did not plant the seeds directly into the fields from which the rice would be harvested. Instead, they would sow the grain in smaller “nursery” fields, with the seedlings coming up as tightly spaced as possible. Once the seedlings were about eight inches tall, they were removed from the nursery field and transplanted into the field in which they were to grow to maturity. In these flooded fields, the seedlings would be individually planted into the soft mud, spaced several inches apart so that they would have sufficient room to finish their growth. As a result, farmers could get a head start on the season’s second crop while the first crop was still ripening. However, these techniques were very labor-intensive and tied large numbers of people to the land. (By contrast, the methods used in modern commercial rice farming in the United States, where labor is expensive and land is cheap, are more typical of grain farming; seeds are sown directly into the field in which the rice matures.)

Chinese farmers also squeezed additional productivity out of limited acreage by taking advantage of the fish that often infiltrated the flooded fields. These fish would eat weeds and aquatic insect pests that would otherwise lower yields and spread diseases. Shortly before the fields were drained, the farmers would harvest the fish, adding protein to diets that were otherwise heavy in starches. Eventually they would deliberately introduce selected species of fish into the rice fields at the beginning of the flooding cycle so they could control pests during the growing season and later harvest the resulting fattened fish.

As the primary staple of the region, rice became associated with

LEADING RICE-PRODUCING COUNTRIES IN 1994



Note: World total for 1994 was approximately 535 million metric tons.

Source: U.S. Department of Commerce, *Statistical Abstract of the United States, 1996*, 1996.

various festivals and rites of passage in Chinese culture. Even Buddhist ceremonies imported from India were adapted by the Chinese to include rice. Rice wine became the principal alcoholic beverage of the rice-growing regions of China. Although often connected with Japan, where it is known as *sake*, it was first brewed in China. Because of the revenues associated with the production of rice wine, several dynasties made it an imperial monopoly.

Although most Westerners tend to think of rice primarily in terms of food, the Chinese also made a large number of products from other parts of the rice plant. One of the most notable was paper made from rice straw. Rice paper was very smooth and white, with a fine grain that accepted ink very well, leading to new and more subtle techniques of painting, in particular, the Chinese forms of ink wash and watercolor. As a result, the Song Dynasty (Sung; 960-1279) saw an extraordinary flowering of the art of painting, rarely equaled and never exceeded by later generations of painters.

SIGNIFICANCE

The introduction of rice to China had an effect on Chinese culture that went far beyond agricultural and culinary habits. Intensive rice

cultivation using the two-field method and multiple crop seasons per year greatly increased the carrying capacity of the land, enabling the population of China to increase until it would become the most populous country in the world. It also led to the development of a very large class of extremely poor peasants performing intensive stoop labor throughout the year for relatively little return and, as a result, locked Chinese culture into a system of extreme stratification with a large gulf between the wealthy leisured classes and the toiling peasantry. Meanwhile, China would come to lead the world in rice production and hold that position into the twenty-first century.

Leigh Husband Kimmel

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■ 1075-C. 1220

MAPUNGUBWE STATE IS BUILT ON CATTLE CULTURE

During the late eleventh century, a centralized state emerged in southeastern Africa. Although other populations had long inhabited this region of Africa, no centralized, commercial, and semiurban focused towns have been uncovered except for Mapungubwe and its successor states.

LOCALE: Limpopo River Valley, Zimbabwe Plateau, and southeastern Africa

AGRICULTURAL ISSUES: Animal husbandry; Archaeological discoveries; Cattle keeping; Ecology and environment; Marketing and trade; Subsistence agriculture

SUMMARY OF EVENT

During the tenth century, a political ideology emerged along the southern riverbank of the Limpopo River bend that was focused in the centrality of the chief or king. In southeastern Africa, this was a new political concept that utilized redistribution of wealth, which was a twofold or mutual obligation: The chief had the privilege to collect half of all of the profit made in luxury trade (valuable stones and beads, gold, ivory, and other such commodities)—which those engaged in trade were obligated to remit—but in times of economic stress or political crisis, the chief was also obliged to provide security to the population, which in turn bestowed their loyalty to the chief.

The primary basis for the chief's power, authority, and affluence was the possession of a large quantity of cattle, because cattle could always provide food in times of economic or ecological crisis. Because the soils of the Mapungubwe state were not the most fertile for agricultural production, the raising of livestock had become a significant component in the Mapungubwe subsistence economy. Thus, the southeast relied on an agropastoral economy with an immense weight placed on pastoralism and particularly the accumulation of large herds.

During the late eleventh century, the new basis of power, which began to build greater wealth concentrated in the hands of the few chiefs, was the catalyst for the appearance by the twelfth century of the Mapungubwe state. By the twelfth century, the Mapungubwe state was drawing its wealth not only from cattle but also from trading gold and ivory to the international markets on Indian Ocean networks. The wealth of the state or the chiefs came not primarily from cattle or even gold but rather from the exploitation of ivory for export to the coast, from where Swahili merchants transported it into the wider world. Ivory was more important than gold because the Mapungubwe state could better control the hunting of elephants but did not control the mining of gold. The Mapungubwe rulers had power over taxation of the precious metal only as it passed through the region; they did not control production. While the wealth of the state was based on the exploitation of gold, cattle, copper, and ivory in international trade, the authority and power of the state were derived more directly from the king's ability to build up wealth in political and social dependents and to acquire livestock to support them.

As Swahili trade expanded in volume, traders explored new sources for commodities farther south, on the Indian Ocean coast. Chibuene, which was just east of Mapungubwe, became a productive port of trade because of this international interest and demand for both gold and ivory. Besides the urban center of Chibuene, the southeastern interior had a town with important significance for trade. This town was the site of Mapungubwe; hence, the commercial center merged with the state as the site of kingship and the exchange of gold, copper, and ivory from three different regions of Southern Africa—the regions currently known as the Zimbabwe plateau, the Transvaal, and the Limpopo River Valley—which respectively controlled each of these three commodities of exchange.

Mapungubwe was distinct from the previous political and social units that existed in this corner of southeastern Africa for several important reasons. First, it was established not on the plain, as were Leopard's Kopje and many smaller political entities, but on a hilltop, enclosed by large stone walls around the cattle kraals, grain bins, and households. Second, Mapungubwe's political organization was clearly an attempt to limit economic and political segmentation. Po-

litical divisions of small chiefdoms circumscribed the amount of centralization, the concentration of power, and the size or extent that the state was able to achieve. By contrast, the social hierarchy indicated in the layout of Mapungubwe demonstrates that it consisted, not in a multiplicity of chiefs ruling over various different populations and the territories they occupied, but rather in a single chief or king who ruled over subjects and delegated power to subordinate chiefs. Third, the archaeological evidence of Mapungubwe also demonstrates a more privileged elite who enjoyed a greater variety of luxury. Grave wares included gold-plated items and beads in the larger burial sites of individuals presumed to be from the elite classes. The technology of spindle whorls found in Mapungubwe sites indicates that new categories of work were developing and that cloth was being produced. In addition to cloth, pottery was significant in Mapungubwe's archaeological record beginning in the eleventh century.

Mapungubwe not only was an important locus for orchestrated trade but also served as an important ritual site for adherents of locally based religious ideologies that emerged among the population. In other words, Mapungubwe was of spiritual importance, and even after the collapse of the site politically, it continued to serve as a religious shrine, demonstrating that the religious significance and symbolism of a location cannot always be easily erased in the same manner that its political importance can be eliminated.

Mapungubwe was abandoned in the thirteenth century, most likely because the hilltop settlement became ecologically and environmentally uninhabitable as a result of the density of human and cattle populations and partially because of the economic downturn resulting from a shift in the trade patterns at the coast. In the stead of Mapungubwe, an even larger state emerged at the site of Great Zimbabwe farther to the north.

SIGNIFICANCE

Mapungubwe presents the earliest evidence, archaeological or historical, of a centralized state in Southern Africa headed by a king. Mapungubwe demonstrates the function of economic wealth in building a centralized state. In the twelfth century, the wealth produced from ivory was tremendous, while by the thirteenth century,

the Mapungubwe state had shrunk considerably and virtually collapsed as ivory trade declined and as Swahili merchants abandoned Chibuenene and concentrated commercial activities in ports farther north.

Mapungubwe seems to be a political precursor to Great Zimbabwe, which emerged to the north of Mapungubwe in the thirteenth century. Much of the material culture and architecture of Great Zimbabwe demonstrates continuity in style, structure, and function with the culture and institutions that have been identified for Mapungubwe a century earlier to the south.

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SCIENTIFIC CATTLE BREEDING IS DEVELOPED IN EUROPE

The scientific revolution in agricultural techniques that characterized the twelfth and thirteenth centuries was largely the result of work carried out on the monastic farms of newly founded religious orders, particularly the Cistercians, who became especially well known for their scientific approach to farming and livestock raising.

LOCALE: Europe

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Innovations; Scientific research; Textile industries

SUMMARY OF EVENT

The twelfth century origin of the Cistercian order is significant in that it forced the Cistercians into a consciousness of rural problems. Compared with the Benedictines and their already reformed Cluny, the Cistercians started late as an order. Since, by the twelfth century, the earlier monastic groups had preempted many of the more favorable agricultural sites in Europe and most of the best arable land of Western Europe had already been put to the plow, the new order was forced to retreat into less accessible areas. Also, since the Cistercians were encouraged by their rule to shun the general population, the monks tended to establish their houses in the wilder and more remote lands of England, France, and Germany. In these primitive surroundings, they were in a sense free, but this fact forced them to experiment with new techniques in agronomy.

Of significant importance in their freedom to plan was the actual management of the Cistercian lands themselves. The monasteries divided their newly acquired areas into compact groups known as granges. Each grange included arable, pasture, and timber lands, and was put under the care of one man, a cellarer, who was responsible for its effective management. Such an arrangement lifted the granges outside the normal manorial nexus and, by freeing them from the hampering restrictions, dues, rights, and obligations in-

volved in the established agricultural structure, provided wide opportunities for innovation.

Because other orders already held the Midlands, the Cistercians in the British Isles settled mostly in the Yorkshire dales, and in the moorlands and valleys of Wales. Here they turned into exceptionally fine sheep farmers. Their close ties in the wool trade with Flanders later had its impact on the Hundred Years' War (1337-1453). In fact, the Cistercian wool trade was so highly developed that the monasteries disposed of their wool by advance contracts promising to deliver a set amount of wool for two, three, or even fifteen or twenty years. Thus wool merchants were in effect making long-term loans to the monks on the security of their future production. Because the monasteries made contracts not only for the wool of their own domains but also for that of other farmers in the area, they were actually acting as middlemen between the exporter and the small farmer. Although the Cistercians were forbidden in 1157 by their chapter general to engage in such economic speculation, they found these long-term contracts too lucrative to forgo.

Cistercian agriculture, grain production, and cattle raising were greatly stimulated on the great Flemish estates of the order when the monks began to produce for the growing towns. Intensive cultivation of the land drove out the old fallow policy, and the urban demand for meat, milk, and cheese, together with a climate favorable for pasture farming, led to a great expansion and improvement of livestock raising during the late thirteenth century.

Soon the monks became famous for their advanced concepts of animal husbandry. Cattle, sheep, and hogs were generally allowed to roam the open fields, meadows, and forests and to mate indiscriminately among their own kind, but the Cistercians began to enclose their grasslands with fencing so that undesirable strains of cattle and uncontrolled inbreeding could not contaminate their herds.

Selective breeding developed in the monks' cattle many desirable characteristics: resistance to disease, endurance of cold weather, capacity for greater milk production, and, in the case of beef cattle and hogs, greater size and weight.

In Germany and the Low Countries, the Cistercians became expert in clearing and draining vast tracts of wasteland and low-lying swamp areas. The water obtained by the drainage of swamp and fen



Cattle roaming near the ruins of the Cisterian monastery at Irantzu, Spain. (©Wessel Cirkel/Dreamstime.com)

was ingeniously stored behind specially constructed dikes and dams to reclaim additional acres by irrigation. In central and eastern Prussia, the Cistercians actually reclaimed the entire so-called Thuringian Basin. At the same time, the monastery of Waldsassen in Germany, while largely supporting itself by the export of its dressed lumber, set a standard in the conservation of its native timber.

SIGNIFICANCE

The Cistercians, as a twelfth century reform movement in the Western Church, preferred to establish fresh religious foundations rather than to try to reform older monasteries. More from necessity than choice, they tended to locate in places uninhabited for centuries, “thick set with thorns” in mountainous and rocky areas more suited as a “lair of wild beasts than the home of human beings.” Capital gained through donations and earned through the patience of hard work, together with the monks’ knowledge of ancient agricultural writings, helped them turn their inhospitable abodes into fertile areas despite wars, raids, diseases, great economic hindrances inflicted on the order’s trade by the state, and the sharp fall in the value of

money during the twelfth and thirteenth centuries. As the monasteries prospered, thousands flocked to work for fixed wages.

The wool industry of the Cistercians grew rapidly as well; within forty years of their foundation they were widely known as great wool raisers. By the middle of the fourteenth century the yearly export reached forty thousand sacks shipped mainly from the port of Boston not only to Flanders but also to distant parts of the world in vessels of many countries.

With such a reputation in agronomy and animal husbandry, the Cistercians were much sought after in Western Europe. They were encouraged by liberal grants to settle in Poland, for example, where they contributed not only to the economic advance of the country but to the uplift of its social and moral tone as well.

Carl F. Rohne

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FAILURE OF ANNUAL NILE FLOODS BRINGS FAMINE TO EGYPT

For millennia, the peoples of lower Egypt have relied on the annual floodwaters of the Nile River to sustain the agriculture on which the entire region depends. For several years during the early thirteenth century, the annual floods failed, with catastrophic results, setting back food production and leaving more than 100,000 people dead.

LOCALE: Egypt

AGRICULTURAL ISSUES: Climate change; Drought; Famine and hunger; Irrigation and water management; Natural disasters

KEY FIGURES

Abd al-Latif (fl. thirteen century), Arab scholar

SUMMARY OF THE EVENT

From the earliest beginnings of agriculture until the building of modern dams in the twentieth century, the people of Egypt depended on the annual flooding of the great Nile River for their survival. In typical years, the Nile began to rise in late June and reached its highest level in the middle of September. Its water then receded, leaving behind thick layers of silt that allowed crops to be grown. Without this flooding, the land surrounding the Nile would have become a barren desert, like the vast arid regions that surround its lower reaches.

During the year 1200, two months before the annual flooding of the Nile began, the Nile's water turned green and acquired an unpleasant taste and odor. Boiling the water did not improve it, so Egyptians turned to drinking well water instead. *Abd al-Latif*, an Arab scholar who left an eyewitness account of the famine, determined that the river's water was full of plant matter and correctly surmised that the condition had been caused by a lack of rain at the source of the Nile. Although the water eventually returned to normal, the annual flooding failed to reach its usual level.

MODERN EGYPT



A level of about 28 feet (16 cubits) was considered necessary to produce sufficient crops. According to records kept for six hundred years, the Nile had risen to only 24.5 feet (14 cubits) twenty times and only 22.75 feet (13 cubits) six times. Previous failures of the Nile to reach adequate levels had led to famine. In 1064, a famine that lasted until 1072 resulted in between 25,000 and 40,000 deaths. On September 9, 1200, the Nile reached its highest point for the year, at a level below 22.75 feet (13 cubits).

Knowing that this extremely low flood level would lead to severe food shortages, thousands of Egyptians fled the country to seek ref-

uge in other areas of North Africa and the Middle East. Huge numbers of farmers left their unproductive fields, leading to overcrowding in the cities. By March of 1201, starvation in the cities reached the point where the poor were reduced to eating dogs, carrion, animal excrement, and corpses.

As the famine progressed, children, who were often left unprotected by the deaths of their parents, were killed and eaten. The government of Egypt sentenced all those who ate the flesh of children to be burned at the stake, but the murders continued. Latif records that he saw the parents of “a small roasted child in a basket” brought to the ruler of Egypt, who condemned them to death. Ironically, the burnt bodies of those executed for cannibalism were released to the starving populace for legal consumption.

The famine spread from the cities to all parts of Egypt. Adults as well as children were in danger of being murdered, even by the wealthy. Workers, brought into homes to perform their duties, and guests, invited to social events, were sometimes killed and eaten by their hosts. The corpses of those who died of starvation filled every town. In Cairo, between one hundred and five hundred bodies were carried away daily. Latif visited a pile of about twenty thousand bodies in order to study human anatomy.

Meanwhile, in April of 1201, the water of the Nile again turned green, a sign that the annual flood would once more fail to reach the level needed to relieve the famine. In early September of 1201, the Nile’s maximum level was about 28 feet (below 16 cubits), then immediately began to drop back. Although not as severe as the extremely low flood level of 1200, the rapid decline of the Nile ensured that starvation would continue.

The second year of the famine resulted in fewer deaths than the first year, mostly because the population of Egypt, particularly among the poor, had already been greatly reduced. As an example of the reduced population, Latif records that the number of rush-mat makers in the city of Misr fell from 900 to 15. The population of the cities, so recently increased by refugees, fell so rapidly that rents decreased by as much as 85 percent. Even the price of wheat fell; although there was still a severe shortage of food, the number of buyers had been drastically reduced.

In early 1202, plague broke out in many parts of Egypt. The dis-

Failure of Annual Nile Floods Brings Famine to Egypt



Egyptian women carrying water jars from the Nile in Cairo around the turn of the twentieth century. (Library of Congress)

ease acted so rapidly that farmers fell dead while working their plows. In the city of Alexandria, funeral prayers were said for seven hundred people in a single day. Between July of 1200 and April of 1202, the official number of deaths in Egypt was reported to be nearly 110,000. This number did not include many deaths that government officials failed to record.

In February of 1202, the Nile again turned green, leading to expectations that the annual flood would once more fail to reach a level adequate to sustain agriculture. Many Egyptians began to suspect that the source of the Nile had been altered in some way, so that flood levels would never return to normal. On May 20, 1202, a series of violent earthquakes struck Egypt, adding to the number of deaths.

The Nile rose very slowly from the middle of June to the middle of July, discouraging those who hoped for relief from starvation. After the middle of July, however, the Nile rose more rapidly, reaching a level of about 5.25 feet (3 cubits) and remaining steady for two days. The Nile then swiftly increased to a maximum level of about 28 feet (16 cubits) on September 4, 1202. Unlike the flood of 1201, which had declined quickly, the Nile remained at this level for two days, allowing adequate silt to be deposited, then dropped slowly. The return of the Nile to its normal behavior brought two years of devastating famine to an end.

SIGNIFICANCE

The failure of the Nile's annual flood during the early thirteenth century had disastrous consequences for Egyptian agriculture and revealed the dependence of Lower Egypt on the river's water. The fact that until the mid-nineteenth century neither Egyptians nor anyone else knew where the Nile originated contributed to a mystique about the annual flooding. Efforts were made to control the annual floods by building dams, but no real progress was made until the completion of the Aswān High Dam in 1971.

Rose Secrest

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■ EARLY 1460's

POST-PLAGUE LABOR SHORTAGES THREATEN EUROPEAN AGRICULTURE

In the decades following the plague, a labor shortage radically altered the social and economic structures of Europe. Populations dwindled and family sizes decreased, and the economy transformed from one that was primarily agricultural and based on the bartering of services to an economy based on the marketplace and the selling of agricultural and manufactured goods.

LOCALE: Europe

AGRICULTURAL ISSUES: Labor; Marketing and trade

KEY FIGURES

Fugger family (1367-1806), dominant merchant banking family in Augsburg, Germany

Henry VIII (1491-1547), king of England, r. 1509-1547

Elizabeth I (1533-1603), queen of England, r. 1558-1603

SUMMARY OF EVENT

The bubonic and pneumonic plagues that terrorized Europe in 1348, and again at irregular intervals in the succeeding century, had a devastating effect on Europe's human capital. Though the exact numbers of deaths may never be known, it is now estimated that about 40 percent of Europe's population died. In comparison, the memorable widespread health disaster of the twentieth century, the influenza epidemic of 1918-1919, killed about 0.5 percent of the U.S. population.

In addition to the ravages of the plague, the endemic warfare of the fourteenth and fifteenth centuries wreaked havoc on the countryside of France and England. Military action, but also the devastation brought about by unpaid mercenaries who pillaged at will, reduced the economies of much of Western Europe tremendously.

By the time the European economy began to recover, from the 1460's onward, severe population decline had changed the social

During the late fifteenth century, Europe's economy transformed from one based on agriculture and the bartering of services to one selling goods and services for money.
(Frederick Ungar Publishing Co.)



structure of the continent in profound ways. Whereas, prior to the plague, population growth had pushed agricultural production to the margins of suitable land, after the plague, the number of people available to carry out the sowing and the reaping was reduced severely. The prior system of agriculture management, the manorial system, had relied on some nine-tenths of the population to do the hard work in the fields. These field workers were serfs, bound to the soil and its cultivation.

With a 40 percent reduction in available workers, however, serfs could bargain in ways that had been unavailable to them, for the laws of supply and demand worked then as they do in the twenty-first century. The serfs—the remaining agricultural workers—were able to demand that their obligations to the landlord be fulfilled, not with labor services but with money, and small amounts at that. They were able to demand the right to take over the plots of their neighbors who had died, in many cases becoming landowners themselves. They were able to convert plots that were no longer being cultivated into

pasturage, to own that acreage's grazing cattle and sheep, and sell the livestock if they so desired. Also, they had the option, if slight, to relocate to urban areas to look for work.

In the century or so after the plagues became infrequent and more localized, the surviving populace looked quite different from the one that had prevailed in the first half of the fourteenth century. Instead of a relatively uniform agricultural labor force, what emerged was one that was highly differentiated. At the top of the labor scale were active landlords, who rented out their land for money or who hired stewards to cultivate it for them and to sell the produce at market. Midway on the scale were agricultural workers who had their own holdings but who sold their labor for money to the large landlords. At the bottom were those without land, or with perhaps no more than a small plot with a cottage and a garden, who supported themselves entirely from their wages.

As the agriculture-based system converted to a market-based system, many chose to leave agriculture altogether and migrate to the towns. Even though towns were breeding grounds for the plague and other diseases because of their inadequate sources of water and waste disposal, they had jobs for those who had nothing to sell but their labor. Getting goods, both agricultural and manufactured, to the marketplace required the efforts of many, as the new market-based economy flourished.

Agriculture shifted from crops (grain was needed less and less because of the smaller population) to pasturing livestock. The market for sheep's wool, for example, increased because sheep were being raised in areas once dominated by croplands. When there seemed to be a shortage of land for the market-based production of grain and wool in England, King Henry VIII seized the land-rich monasteries there in 1546 and disbanded them, opening the monastery lands to the cultivation of crops and the raising of sheep.

Before wool could be sold, it had to be spun and woven, so many came to earn their living weaving woolen cloth. Whereas England and Spain exported ever-larger amounts of wool, laborers in the Low Countries and in Italy spun and wove the wool into cloth. Profits from trade supported a growing urban middle class. Construction in many urban areas grew substantially, and builders prospered; their wages doubled between 1350 and 1500.

EARLY 1460's

As many parts of Europe depended more on trade than they did on agriculture, those who had once controlled land shifted their focus. They rented out the land they controlled directly, often to men who made their living managing agricultural activity. They converted their castles and manor houses into country residences and lived there only part of the time. Also, they devoted far less of their time to military service and far more to administrating the growing national kingdoms.

Those members of the new middle class who were lucky enough to own land in the major urban centers, such as London or Paris, became rich renting out their properties. They would invest their profits in the innumerable government loans issued by the new national rulers, becoming, in effect, “rentiers,” living off the income generated by their assets, both real and financial. The wealthy Fugger family of Augsburg, Germany, controlled most of the silver mines in Austria and lent money to the Habsburgs, the ruling family in Germany. Several Italian families, including the Medici, had become rich through trade and became rulers also.



Sheep shearing in late fifteenth century Europe. (Frederick Ungar Publishing Co.)

SIGNIFICANCE

The devastating drop in Europe's population between 1348 and 1450 had social consequences that reached beyond the conversion to a market- and, hence, money-based economy: The structure of the family changed. Starting during the late fifteenth century, the population began to recover. Sometime in the sixteenth century, and in some places, the population reached the level that it had achieved two hundred years earlier.

Europeans were still wary, however, about returning to the conditions of that earlier time, so they tended to restrict their family size to one that they knew they could sustain. Modern studies show that by delaying marriage, Europeans would limit the number of children they had depending on anticipated income from land holdings or from the parents' job. Even though many had the chance to emigrate to the newly forming colonies of the New World, this cautious approach to reproduction continued. Not until the nineteenth century did Europeans again begin to create large families, when the Industrial Revolution offered new means of support.

Not all attempts to balance family size and means of support were successful. The late fifteenth and especially the sixteenth century witnessed "sturdy vagabonds," unemployed men roving the countryside. During the reign of England's queen Elizabeth I, vagabonding became such a problem that attempts were made to restrict those needing public assistance. Men would receive that help if they limited their residence to their place of birth. Some of these men could be pressed into military or naval service, but they were generally unwilling soldiers and sailors. Europe began to confront the issue of welfare.

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■ 1471-1493

INCA EMPIRE EXPANDS AND STRENGTHENS ITS ECONOMIC SYSTEM

Topa Inca's conquests added to the extensive and thriving empire conquered by his father, Pachacuti, and solidified Incan control over the empire's subject peoples.

LOCALE: Andes Mountains and west coast of South America (now in Peru)

AGRICULTURAL ISSUES: Government policy and regulation

KEY FIGURES

Pachacuti (c. 1391-1471), ninth king, father of Topa Inca, r. 1438-1471

Topa Inca (d. 1493), tenth king, r. 1471-1493

Huayna Capac (1488?-1525), eleventh king, son of Topa Inca, r. 1493-1525

SUMMARY OF EVENT

During the early fifteenth century, the Inca controlled the region around Cuzco, Peru, only. Their expansion over much of western South America began with the accession of the ninth king, Pachacuti, in 1438, who led forty thousand inhabitants of the Cuzco region on a spectacular course of conquest. Using superior tactical leadership and recruiting soldiers from conquered groups, Pachacuti built an empire that ultimately included some ten million subjects.

In 1463, Pachacuti gave control of the army to his younger son, Topa Inca, who continued the northern expansion of Incan territory, while Pachacuti concentrated on organizing the empire more efficiently and rebuilding the capital city of Cuzco. When Topa Inca assumed the throne in 1471, his realm stretched along the Andean highlands from modern Ecuador south to Lake Titicaca on the Chilean border. Topa Inca added to his domain the coastal regions of Peru, the northern half of Chile, and portions of Bolivia and northwest Argentina. Huayna Capac, Topa Inca's son, added jungle territory to the Incan realm.



Alpacas grazing on the Andean altiplano. During the Inca era, these animals were bred primarily for their wool. (Library of Congress)

Rulers were given the title “Inca.” The word also designated the inhabitants of the Cuzco valley who claimed descent from the original settlers. The name was extended to neighboring tribes adopted by the Incas, who spoke the same Quechua and were early allies. Loosely applied, the term “Incan” expanded to cover the subject peoples of the Incan state, although they were actually a very diverse collection of more than one hundred tribes and kingdoms, speaking many languages, and considered inferior by the original Incas.

To unite their 1,800-mile-long empire, the Incas built two main highways, one along the coast and the other in the highlands, with many transverse roads. Well-constructed bridges carried the roads over intervening rivers, permitting rapid movement of the army and easy transportation of tribute to Cuzco. The Inca possessed neither the wheel nor draft animals; the roads carried foot traffic and llamas bearing merchandise. Fish could be brought to Cuzco from the coast in two days, arriving fresh enough to eat—after the Spanish conquest, horses and wagons took a week to make the same trip.

The Inca were outstanding engineers and architects. They con-

structed elaborate road and bridge systems and erected monumental public buildings by fitting together huge stones seamlessly without the use of mortar. Carefully built stone walls testified to the importance of a building and to the high status of its occupants. Many walls demonstrated the skills of their builders by remaining intact more than four hundred years in an earthquake-prone region. The Incas built terraced fields on mountain slopes, supplying water through intricate irrigation canals. Acreage under cultivation and the quantity of food produced increased, easily supporting the Incan army and large governmental and religious organizations.

The Inca had no coinage and no concept of money. Their vestigial trade consisted of bartering surplus goods. Wealth meant controlling the labor of subordinates and possessing land and livestock. Strictly speaking, subject peoples were not taxed; however, they owed labor service, which might consist of working on roads or public buildings, cultivating state and temple lands, transporting goods, or serving in



Modern Andean farmers selling their produce in an Ecuador market. (PhotoDisc)

the army. The Incas claimed all land as property of the king and divided their conquests by reserving one-third for the state, one-third to support the religious establishment, and allotting the rest to the people.

Agriculture was the main economic activity. Depending on altitude and the suitability of the soil, a variety of native plants were grown, including white and sweet potatoes, tomatoes, chili peppers, squash, and many kinds of beans. The major crop, however, was corn, which was used directly and also fermented into corn beer (*chicha*), and consumed with meals and during ritual ceremonies. The main domesticated animals were llamas, valued as pack animals primarily but also sometimes eaten, and alpacas raised for their wool. In addition, ducks and guinea pigs augmented the Incan diet.

Incan society was stratified into rigid hierarchical lines. At its pinnacle sat the Inca, claiming divine status as a direct descendant of the Sun god. The eldest son did not necessarily inherit the throne; the king designated the son he thought most capable as his successor. Each ruler built palaces for his wives, concubines, and children, endowing the group with extensive fields. The descendants of a deceased king were charged with conserving his mummy, carrying out family rituals, and occasionally showing the mummy to the people while reciting his great deeds. Ranking directly below the royal Incas were the descendants of the first settlers of Cuzco, who were not subject to any labor requirement and were assigned servants from among the conquered people. Next in status were the Incas-by-privilege—inhabitants of areas near Cuzco who were early allies of the Incas. They were exempt from labor requirements and often served with the Incas-by-blood as administrators in the imperial bureaucracy. The Incas recruited promising members from conquered peoples to be leaders of villages and small administrative districts. They formed a lower nobility, a status inherited by their descendants.

Ordinary people of the conquered tribes made up the lowest, but largest, segment of the population. Extended families, consisting of several generations, lived in one-room, rectangular, adobe houses with thatched roofs. Nearby were homes of kinfolk, sometimes arranged within a walled compound. Each family was assigned land to raise its own food; kin groups joined together to carry out required work on state and temple lands. Skilled workers crafted graceful pot-

tery, wove cotton and alpaca wool into cloth, and produced bronze tools and utensils.

The Incas did not possess a written language. To record information concerning their vast empire, the Incas depended on the *quipu*, a set of strings with knots tied at various positions to indicate numbers. The strings hung from a main cord, and their location indicated the object recorded. A skilled group of labor-exempt workers constructed and interpreted the *quipus*. Modern scholars have decoded the numerical *quipus* and shown that they used a decimal system and employed the concept of zero. Incas also recorded the genealogies and life histories of the kings on *quipus*, but no scholar has yet deciphered any literary *quipu*.

The principal deity of the Incas was the Sun god, claimed as the direct ancestor of the royal line. The Incas did not force subject people to abandon their own gods, but insisted they accept the superior position of Incan deities. Incan religious structures were called Houses of the Sun, but they also contained images and altars dedicated to other gods. Important deities included a thunder or weather god, a moon goddess, and a creator god.

The Incas attributed supernatural powers to specific places and objects. A hierarchy of priests and priestesses devoted themselves full-time to temple rituals, supported by produce from one-third of the empire's land. Rituals almost always involved some form of sacrifice. Corn beer might be poured in front of the altar, food or cloth might be burned, guinea pigs or llamas might be slaughtered. Even the poorest Incan inhabitant could participate in such rituals; tearing out an eyelash in honor of the Sun was an acceptable sacrifice. In times of natural catastrophes, famines, and plagues, or when celebrating a king's coronation, human sacrifices were offered—usually children ten to fifteen years old.

SIGNIFICANCE

When Topa Inca died in 1493, he left his son Huayna Capac a powerful and solidly established kingdom whose permanence seemed assured and whose expansion appeared unstoppable. In the short span of fifty-five years, Pachacuti and Topa Inca had created one of history's greatest empires. Wealth poured into Cuzco, providing a magnificent lifestyle for the Incan nobility and supplying the material ba-

sis for expectations of endless growth. Although restless subject peoples occasionally rebelled, the Incan armies defeated every insurgency. The Incan system of government molded the Andean Indians into a dominant Incan image. Quechua replaced the many indigenous languages spoken before the Incan arrival. Sacrificing to the Incan gods seemed much more useful than appealing to previously worshiped deities.

With hindsight, one can see that the empire had grown close to its natural limits. Topa Inca had ended his southward drive when the cost of conquering the fiercely resistant Araucanian Indians greatly exceeded any prospective benefit. Huayna Capac pushed into northern and eastern jungle areas, but made slow progress and found material rewards elusive. No one, however, could have foreseen the catastrophic threat to the Incan future posed by the arrival of Christopher Columbus in the Caribbean, one year before Topa Inca died, and the subsequent conquest of the Inca by Francisco Pizarro in 1533.

Milton Berman

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■ BEGINNING C. 1500

COFFEE, CACAO, TOBACCO, AND SUGAR ARE SOLD WORLDWIDE

Asian and New World foods were among the first items of global trade. While Europeans treated most new foods with apprehension or grew them as botanical curiosities, coffee, tea, cacao, tobacco and sugar became important plantation crops as colonies were founded and worked by slave labor to satisfy Europeans' desires.

LOCALE: Worldwide

AGRICULTURAL ISSUES: Botany; Diet, nutrition, and cuisine; European colonization; Marketing and trade; New crops and food products; Slavery; Tropical produce

KEY FIGURES

Vasco da Gama (c. 1460-1524), Portuguese navigator and the first European to reach India by sea

Christopher Columbus (1451-1506), commander of the first Spanish voyages to the New World

Nicolas Monardes (1493-1588), Spanish physician whose books, written during the 1560's and 1570's, were among the first to introduce New World plants to Europe

SUMMARY OF EVENT

The original impetus of European exploration was to find a sea route to Asia to gain direct access to the spice trade. The Portuguese accomplished this at the end of the fifteenth century by rounding the southern tip of Africa in 1488 under Bartolomeu Dias and eventually with the voyage of Vasco da Gama in 1498, which reached India. India became a launching pad for the establishment of numerous trading posts throughout Southeast Asia and ultimately the Spice Islands, or Moluccas, now in Indonesia. In the long run this route circumvented the Venetian spice trade in the Mediterranean via Arab middlemen, increasing the volume of spices reaching Europe, lowering their cost, and thereby making them commodities that enjoyed more widespread consumption.

*Beans hanging
from the branches
of a coffee tree.
(PhotoDisc)*



Hoping to find a westerly route to Asia, Christopher Columbus was commissioned by Isabella, the queen of Castile, in 1492 to venture across the Atlantic and around the globe. Seriously underestimating the circumference of the earth, Columbus believed he had landed somewhere off the coast of Asia when he arrived in the Caribbean. Columbus and his men were the first Europeans to taste the sweet potato, yucca, corn, chilies, and tobacco. These New World products, along with tomatoes, new varieties of beans, squash, turkeys, and eventually cacao from Mexico and potatoes from South America, were soon exported to Europe.

Those foods that readily fit a culinary niche occupied by a similar and familiar food were soon enthusiastically adopted. For example, corn was easy to grow and soon replaced millet and barley in porridges throughout southern Europe. Turkeys were similar to fowl already familiar to Europeans, and New World beans supplemented the varieties already known. None of these, however became major items of world commerce because they could easily adapt to the European climate and were grown at home. In the ensuing decades, chilies were grown in the Middle East and, along with sweet potatoes, found their way to Asia. Tomatoes and potatoes, on the other hand, would take several centuries before becoming major parts of the European diet.

A number of crops could be grown only in subtropical climates, and it was these that fueled colonial expansion. The first was sugar,

originating in Southeast Asia. During the Middle Ages, Europeans had purchased it through Arab merchants, and it remained a rare and expensive luxury. After experimenting with the crop in the southern Mediterranean and on their island possessions in the Atlantic, Madeira, and the Canaries, Europeans found sugar to be the ideal plantation crop. The Portuguese planted it in Brazil, the Spanish in the Caribbean, and eventually the British on Barbados and Jamaica and the French and Dutch in their Caribbean colonies. To satisfy the European sweet tooth, African slaves were imported to these colonies to supply the cheap labor needed, especially after the Native American populations were greatly reduced by European diseases and warfare. Sugar was used in Europe as a practically universal flavoring, not only in confectionery but also in savory dishes, and increasingly in novel new drinks. As a by-product of sugar manufacturing, molasses and rum distilled from it also became items of commerce.

Cacao was the first of the newly introduced hot drinks, discovered in Mexico among the Aztecs, who drank it flavored with vanilla and chilies. The Europeans added sugar and spices, and cacao became the first New World luxury item to cause a sensation. Physicians pro-



Caribbean tobacco plantation. (©Dušan Zidar/Dreamstime.com)

claimed it a wonderfully nourishing and medicinal food, and Spanish nobles were soon found idly sipping hot chocolate throughout the day. When Nicolas Monardes, a Spanish botanist, first proclaimed its virtues in print, chocolate quickly became a status symbol and a major item of commerce at a time when there were few items available for conspicuous consumption.

Tobacco, another New World product, was similarly hailed as a medicinal herb good to combat coughs and colds. Soon its medicinal reputation was eclipsed by its recreational use, despite the fact that some physicians condemned it, as did the king of England, James I in his *Counterblaste to Tobacco*. In the seventeenth century, it would become the crop that sustained the British colony of Virginia, and it led directly to the importation of massive numbers of African slaves into what would become the United States. Other “medicinal” herbs followed a similar fate: After being touted as miracle drugs, they eventually made their way into soft drinks. Sarsaparilla and sassafras (root beer) are prime examples.

Following a more circuitous route, coffee originated in what is now Ethiopia, making its way through Arabia and eventually to the Ottoman Empire, where it was celebrated as a sobering alternative to alcohol, formally forbidden by the Islamic faith. By the seventeenth century, northern European and Protestant countries had enthusiastically embraced coffee as a stimulant that would keep them alert through long hours of work. It also became a vehicle for social and commercial discourse as coffeehouses sprang up and offered a place to quaff the new drink while doing business or discussing politics or the arts. As coffee was grown on a wider scale and became more readily available, it gradually supplanted beer as a typical morning drink, not only for wealthy Europeans but increasingly at every level of society.

Tea had long been an expensive luxury item in Europe and at first lagged behind coffee in popularity. It did not become readily available until the seventeenth century, and it supplanted coffee only in countries such as Britain after they had established plantations in India and protected the trade of tea throughout their empire. In subsequent centuries, sweetened tea became an indispensable part of the British diet at every level of society, often supplanting more nourishing foods in the average household budget.

SIGNIFICANCE

The introduction of Asian and New World foods not only expanded the global economy in ways that anticipated modern trade patterns but also radically transformed the diets of people throughout the world. The Irish came to depend on potatoes for basic sustenance, with disastrous results when this dominant crop was destroyed by blight during the 1840's, followed by famine and migration. Tomatoes and peppers became staples in southern European cooking. The Chinese experienced a population boom after the introduction of sweet potatoes. Coffee continues to be a major commodity grown and sipped throughout the world, and chocolate, especially in solid edible form, provides one of the principal ingredients for the confectionery industry.

Two commodities that have had perhaps the greatest impact, for different reasons, are tobacco and sugar. Tobacco remains one of the major recreational drugs used throughout the world, with unfortunate consequences for human health, but its successful cultivation fueled the economies of fledgling colonies, notably that of Virginia. Sugar, likewise, became a dominant part of the economies of Caribbean colonies, and its entry into the human diet has had perhaps subtler but widespread implications for human health.

These changes are emblematic of a larger and more important phenomenon: The exchange of plants and animals across the globe, which expanded precipitously after fifteenth and sixteenth century exploration laid the groundwork for seventeenth century colonization. This global exchange dramatically altered the biological makeup and ecology of most places on earth, as native flora and fauna succumbed to the invasions, both intentional and accidental, of plants and animals raised commercially.

The impact of new crops was not only dietary and ecological but also social: To sustain their colonial settlements in Africa, Asia, and the Americas, Europeans—who originally had sought quicker access to trade with the East—were desperate to identify and develop new commodities for export to their mother nations. These commodities would make or break the survival of the distant settlements. Over time, resources and particularly labor needed to fuel the success of the new agriculture would lead Europeans to rationalize an increasing dependence on indentured servants and, by the 1620's in the

Americas, slavery. This development had radical implications that would both shape and hinder national identities to this day. The legacy of slavery and colonial plantation economies has left transplanted peoples throughout the world and has contributed significantly to grave imbalances in wealth and standards of living across the planet.

Ken Albala

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■ 16TH CENTURY

NEW AGRICULTURAL TECHNOLOGIES INCREASE CHINESE POPULATION

An increase in cultivated land, new crops and agricultural technologies, humane policies toward newborns, relative peace, and political stability, as well as nascent industrialization, led to a significant increase of Chinese population in the sixteenth century.

LOCALE: China

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Fertilizers; Innovations; New crops and food products; Population growth

KEY FIGURES

Hongwu (reign name, also Hung-wu; personal name Zhu Yuanzhang, Chu Yüan-chang; posthumous name Gaodi, Kao-ti; temple name Taizu, T'ai-tsu; 1328-1398), founder of the Ming Dynasty, r. 1368-1398

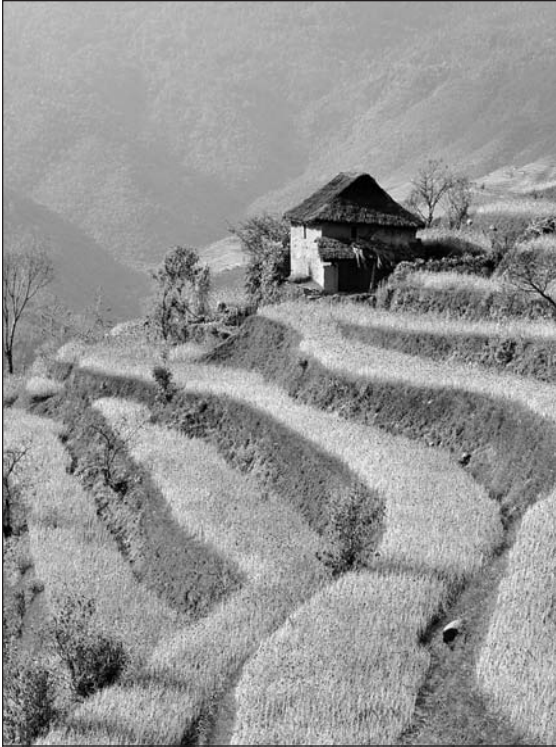
Jiajing (reign name, also Chia-ching; personal name Zhu Houzong, Chu Hou-tsung; posthumous name Sudi, Su-ti; temple name Shizong, Shih-tsung; 1507-1567), Ming emperor of China, r. 1522-1567

Wanli (reign name, also Wan-li; personal name Zhu Yijun, Chu I-chün; posthumous name Zhu Yijun, Chu I-chün; temple name Shen-zong, Shen-tsung; 1563-1620), the thirteenth Ming emperor, r. 1573-1620, a supporter of the Single-Whip Reform

SUMMARY OF EVENT

During the sixteenth century, China experienced a remarkable population increase. This came as a direct consequence of the policies of the Hongwu emperor, who founded the Ming Dynasty in 1368. At that time, China's population consisted of approximately 60 million people. By 1600, this number stood as high as 150 million, according to contemporary historians. This tremendous boom was unprecedented in China's history and provided both opportunities and challenges to the nation and the imperial government. Ironically, the

New Agricultural Technologies Increase Chinese Population



An important technique the Chinese used to improve agricultural production was terracing. Terraces are raised horizontal strips of earth constructed along the contours of hills to slow the movement of downward-flowing water, thereby improving irrigation and reducing erosion.
(PhotoDisc)

Ming emperors of the sixteenth century themselves believed that their population was dwindling, as their subjects avoided the census to escape from paying taxes.

When the Hongwu emperor came to power in 1368, he immediately implemented measures to reverse the population decline under the previous Yuan Dynasty. He launched an aggressive campaign to resettle northern China, which had been devastated by warfare and neglect. Settlers from the populous south were given start-up aid, tax relief, and free land if they moved north. Thus, more of China's land was put to agrarian use and could sustain a larger population. The introduction of sorghum, a crop that can be dry-farmed, also aided food production in the more arid north.

Throughout his realm, the Hongwu emperor rebuilt irrigation systems such as canals, dykes, reservoirs, and terraced rice paddies. A new variety of rice, which originated in Champa (present-day central Vietnam), was promoted. The new rice took about half the time of

Chinese rice to grow and yielded a larger quantity per acre. Even though Champa rice has fewer calories than the Chinese variety, the increase in yield still meant more nutrition was available.

Once irrigation systems were rebuilt, with new pumps or water wheels to aid wet farming, a sophisticated hydraulic agriculture was established. The Ming emperors ordered farmers to plant new crops and to fill the flooded rice paddies with fish. This provided a richer food harvest in two ways: The fish fertilized the soil with their waste, and they also served as a food source.

During the sixteenth century, the increase of cultivated land, especially in the north, and the continuous introduction of new crops meant that the land could sustain the unfolding and accelerating population boom. The European discovery of America also brought new crops to China by way of the Spanish colony of the Philippines. The Ming emperors ordered the peasants to plant these new crops, with positive results. Corn flourished in China and became part of the people's diet. Peanuts and sweet potatoes had the additional benefit that they could be cultivated in drier areas previously left barren. These new crops also allowed for a sophisticated system of crop rotation, because the nitrogen bound in their roots served as a natural fertilizer that refurbished land exhausted by traditional crops. By rotating the plants grown on arable land, Chinese farmers increased food production instead of leaving fields to lie fallow, and this increase supported a rapidly growing population. However, the basic conservatism of Ming society precluded the invention of even more high-yielding agricultural machines, and many farming techniques remained unchanged over the centuries.

The conservative approach of Ming rulers like the Jiajing emperor, who reigned until 1567, also found its expression in a humane attitude toward newborns of both genders. The Chinese were exhorted morally to care for their offspring, and infanticide was discouraged. It was considered preferable to sell young girls, even into sexual servitude, rather than kill them as infants. Even though as many as 70,000 eunuchs were in attendance at imperial courts such as that of the Jiajing emperor, the population continued to increase in spite of the number of boys under ten castrated for this purpose. Similarly, the astonishingly high number of death sentences did not negatively impact population growth.

The absence of large-scale warfare during the sixteenth century in China is considered another major reason for the dynamic population growth of the period. Typically, the Jiajing emperor preferred peace over foreign military expeditions. For example, in 1540, he accepted the formal submission of the Vietnamese emperor, Mac Dang Dung, rather than sending his army into Vietnam. Mongol raiders and pirates were held at bay. In the absence of major conflicts, the Chinese population during the sixteenth century increased without the typical destruction associated with warfare in this era. When the Wanli emperor defended Korea from the Japanese from 1592 until 1598 (when the Japanese abandoned their invasion), the resulting stress on the Ming economy showed how, in contrast, the previous absence of much warfare had nourished population growth.

The Chinese population boom of the sixteenth century was aided also by the beginning of industrialization. Based on a stable agricultural sector, industrial enterprises were born and flourished. Among these were the paper, porcelain, and textile industries.

The manufacture of paper, for example, rose in response to the large state bureaucracy and an increasingly literate population. Paper factories employed and fed thousands of workers who did not depend on tilling the land for their subsistence.

A domestic and international demand for porcelain led to the establishment of industrial-sized kiln combines, sustaining, for example, the one million inhabitants of Jingdezhen. Ironically, the Ming porcelain industry also points at typical limitations hampering further growth that could have sustained an even larger population. For instance, the kilns at Jingdezhen were not perfected further, and profits were often consumed rather than reinvested.

The large-scale cultivation of cotton created a textile industry that rivaled that of the silk industry. At Songjiang, people earned their livelihoods weaving cotton at 100,000 operational looms, while Hangzhou and Suzhou produced their famous silks. Again, however, in these textile industries, further inventions did not materialize that could have matched the pace of industrialization with that of the population growth.

The Wanli emperor did not know it and believed the contrary, but in reality he ruled over an empire with a booming population. Al-

most three times as many Chinese lived under his reign than under the Hongwu emperor. Increased agricultural production freed people to work in trade and the nascent industries, and even the catastrophic earthquake of 1556, which killed approximately 800,000 people, did not halt the population boom. Relative peace, focus on agricultural production, introduction of new crops from the south and the Americas, and modest application of technological innovations in agriculture and manufacturing gave Ming China a material base for the amazing population boom during the sixteenth century.

SIGNIFICANCE

The enormous increase in Chinese population during the sixteenth century created a nation of approximately 150 million inhabitants, nearly tripling the number of people in less than 250 years. For this age, the increase was remarkable. Population increase meant that more people than ever required sustenance. Because their flawed census did not reveal the situation to the emperors, they could neither take advantage of the growing population nor adequately serve its needs and sustain this growth. As a result, hardships developed.

In the north, taxation and a rise of banditry made farming increasingly difficult and prompted people to leave the land. Even in the fertile and prosperous south, food shortages developed because of the imperial government's failure to recognize the needs of the steadily growing population. Industrial profits were often spent on consumption or taxes, leaving insufficient capital to sustain growth. State interference in the economy, as well as an official distaste for nonagrarian production and trade, also began to strangle growth. When the Wanli and other Ming emperors failed to recognize and meet the needs of his people, Chinese emigration to Southeast Asia became one of the consequences.

For all these reasons, and sadly for the Chinese people, the population boom of the late Ming Dynasty proved unsustainable. When the Ming Dynasty fell in 1644, warfare again devastated an already endangered north, and famines spread. Scholars estimate that by 1685 the Chinese population had been reduced by one-third, standing now at only 100 million rather than the estimated height of 150 mil-

lion during the Ming Dynasty. Nevertheless, the next recovery would take less time than the Ming population expansion, and by 1749 there were 178 million people living in China.

R. C. Lutz

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■ 1502-1520

AZTEC AGRICULTURE PROSPERS UNDER MONTEZUMA II

The reign of the last preconquest Aztec emperor, Montezuma II, witnessed the culmination of imperial control over the Central Mexican Plateau. The urban capital of Tenochtitlán boasted a dense, socially diverse population, sustained through a unique productive economy and raised-plot agriculture and augmented by tribute from conquered peoples, before it fell to the Spanish.

LOCALE: Tenochtitlán, Aztec Empire (now Mexico City, Mexico)

AGRICULTURAL ISSUES: Government policy and regulation; Native American agriculture

KEY FIGURES

Montezuma II (1467-1520), Aztec emperor, r. 1502-1520

Ahuizotl (d. 1503), Aztec emperor, r. 1486-1502, and uncle of Montezuma II

Hernán Cortés (1485-1547), Spanish conquistador and conqueror of the Aztecs

SUMMARY OF EVENT

Montezuma II was the ninth emperor of the Mexica, or Aztec, a militaristic culture that had resided in the Valley of Mexico since the early fourteenth century. Montezuma II inherited the territorial acquisitions, diplomatic alliances, and economic institutions that had evolved under his predecessors.

The populations of the Valley of Mexico maintained an uneasy relationship with one another. Political alliances were constructed through marriages and trade networks and functioned to maintain stability. Warfare in earlier centuries was common, as it was under Montezuma II, as individual states attempted to absorb one another.

The Aztecs, from their capital city of Tenochtitlán on Lake Texcoco, united in 1428 with the Texcocans and the Tacubans to form the Triple Alliance, a political-military union designed to conquer and extract tribute. When Montezuma II ascended the throne in

1502 the empire was at its zenith. The previous ruler, Ahuitzotl, Montezuma II's uncle, was an aggressive warrior whose reign was noteworthy for territorial expansion and public works projects.

Ahuitzotl's campaigns included expeditions to the Gulf Coast, the Valley of Oaxaca, and south to the region of the modern Guatemalan border. Most of the Central Mexican Plateau was subdued by 1500. Policy focused on indirect rule, local chiefs being responsible for carrying out Aztec directives. In 1487, the great temple complex was completed, and it would serve as the center of the Aztec world through the reign of Ahuitzotl's ill-fated nephew. The chronicles suggest that more than eighty thousand persons were sacrificed to commemorate the completion of the temple: most likely only a fraction of these sacrifices were realized.

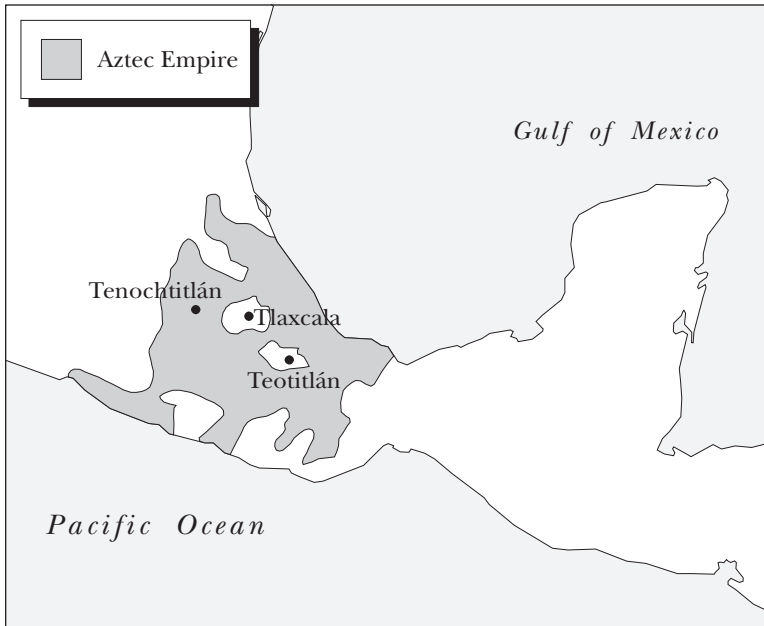
Population growth during the fifteenth century spurred the need to intensify productive agriculture. Fresh water for agriculture and other purposes was directed into Tenochtitlán by an aqueduct, built during Ahuitzotl's reign with a large conscript labor force.

The empire under Montezuma II extended south to the Guatemalan border, northwest to the modern Mexican state of Michoacán on



Fanciful depiction of Aztec ruler Montezuma II.
(R. S. Peale and J. A. Hill)

AZTEC EMPIRE UNDER MONTEZUMA II



the Pacific coast, and due east to Veracruz on the Gulf of Mexico. This vast region of about 77,000 square miles (200,000 square kilometers) contained eleven million people.

Population estimates for Tenochtitlán range from 200,000 to 300,000 individuals. Tribute flowing into the city included foodstuffs, a wide range of luxury goods such as animal skins and feathers, and sacrificial victims. Records from the reign of Montezuma II indicate that 7,000 tons of maize (6,363 metric tons) and 4,000 tons of beans (3,636 metric tons) and other consumables were transported annually into the capital. Endemic warfare ensured a flow of sacrificial victims destined as offerings to the Aztec divinities.

The Aztec pantheon consisted of more than two hundred gods and goddesses. In Tenochtitlán, a great temple complex was dedicated to Tlaloc, the god of rain and water, and to the war god, Huitzilopochtli, a divinity that symbolized the sun. As a powerful celestial force, Huitzilopochtli required consistent sacrifices to ensure his daily movement across the sky. For an agricultural economy, lacking both the benefits of scientific prediction and advanced technology,

the appeasement of these divinities was a perennial preoccupation. Plainly, the religious complex and the ways in which it was integrated with the productive economy meshed with the spectrum of Aztec social institutions. For example, young warriors could elevate their status and earn prestige in the military hierarchy by capturing potential sacrificial victims, rather than annihilating them, on the battlefield.

Intensive cultivation was essential, along with tribute, to provision the great numbers of priests, warriors, and artisans. Nutritional needs were satisfied in part through the chinampa system, which provided four or five crops annually. Chinampas were raised plots of drained land in the lake, filled with vegetation and mud and defined around their perimeters with stakes and trees. The rich soil was easily tilled with hand tools. Supplementing chinampa technology were terraces and irrigation works, all of which functioned to produce maize, squash, varieties of beans, and chili peppers.

At the apex of society was the emperor, or *Tlatoani*, who was elected from the aristocracy on the death of the previous ruler. The ruler and nobility enjoyed privileges withheld from the great mass of commoners: increased land control and the use for their children of the *Calmécac*, a prestigious, strict, religious school. The ruler was advised by a royal council consisting of four aristocrats. Priests and warriors were organized into powerful and prestigious groups. The free commoners, or *macehuales*, while serving important economic functions for society, were denied access to the benefits enjoyed by the groups superimposed above them. For example, dress codes were enforced, as were regulations pertaining to the consumption of certain foods. Beneath the commoners were the serfs who were tied to the lands of the nobility. The *mayeques*, or slaves used in transportation, were positioned beneath the serfs, and this group resulted from bad fortune or warfare.

A select group enjoying substantial prestige was the *pochteca*, or long-distance merchants. Their travels to different lands provided the imperial sector with luxury items and information that could influence military strategy and diplomacy.

The basic unit of Aztec culture was the *calpulli*, a corporate kinship-linked land-holding group. It functioned in religious rituals and provided warriors for imperial aggression. The *calpulli*, of which there were about twenty in Tenochtitlán, provided a patronage sys-

tem in which wealthy members provided less fortunate kinsmen with economic opportunities. Repayment of benefits was usually in labor and tribute.

Aztec norms, mores, and values reflected a rigid religious and militaristic society. Parents inculcated children with the value of subordination to all in institutions of society: the family, the religious culture, and the state. Formal education either in the *Calmécac* or in the school for commoners, called the *telpochcalli*, emphasized discipline and religious codes, and in the *Calmécac*, leadership skills. The values of respect, reverence for traditions, and self-restraint were taught to children through a range of devices. Punishments varied in intensity. Drunkenness, for example, usually carried a death penalty. The issues of social chaos and disrespect would appear to underlie this penalty. Generosity, in the forms of gifts and food, was exhibited at all levels of Aztec society. An emphasis on natural beauty permeated Aztec culture, exemplified in flowers. Oratorical skills, poetics, and stone sculpture were appreciated and highly sophisticated.

The death knell of traditional Aztec culture sounded on November 8, 1519, when Hernán Cortés, a Spanish conquistador, and five hundred soldiers marched into Tenochtitlán. Montezuma II's indecisiveness and his policy of ingratiating the Spaniards facilitated the conquest. During street fighting in June, 1520, Montezuma II was injured, apparently by his own people, and subsequently died. In the end, he had lost the respect and confidence of his people.

Multiple causes led to the collapse of Aztec civilization: diseases to which the Aztec lacked immunity, Spanish persistence and superior organizational skills, steel weapons and cannons, and the invaluable aid of an indigenous interpreter and adviser, Doña Marina. The Aztec practice of indirectly controlling subjugated peoples maintained a loose empire. These dissatisfied peoples became allied with the Spanish and contributed 100,000 warriors in the final assault on Tenochtitlán on August 13, 1521.

SIGNIFICANCE

The Aztec Empire was the largest and most complex of the Mesoamerican civilizations. Spanish accounts, in addition to Aztec books, or codexes, detail the growth, expansion, and florescence of an urban society that lacked the technological benefits of early Old World

agrarian states: sophisticated metallurgy, draft animals for power and traction, and the wheel, which was important in warfare and agriculture. Discipline grounded in religious principles, as well as conformity to norms that elevated the needs of society over those of the individual, allowed the Aztecs to transform from a wandering tribe to a military state in a brief two-hundred-year period.

Rene M. Descartes

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■ 1594-1595

TAIKŌ KENCHI SURVEYS JAPAN'S FARMLAND

The Taikō Kenchi, a nationwide government survey of farmland in Japan, was ordered by Japan's de facto ruler Toyotomi Hideyoshi. Growing out of earlier regional surveys, its definitive findings helped establish the Tokugawa system of agricultural organization and national taxation.

LOCALE: Japan

AGRICULTURAL ISSUES: Feudalistic systems; Government policy and regulation; Land and land policy

KEY FIGURES

Toyotomi Hideyoshi (1537-1598), military ruler of Japan, r. 1590-1598
Toyotomi Hidetsugu (1568-1595), Hideyoshi's heir until Hideyoshi caused his death in 1595

Oda Nobunaga (1534-1582), Hideyoshi's military mentor and one of the three unifiers of Japan, r. 1573-1582

Asano Nagamasa (1546-1610), an aide of Hideyoshi who participated in the land surveys and became an important adviser to the Tokugawa shogunate

Ishida Mitsunari (1563-1600), an aide of Hideyoshi who played an important role in the survey in Hitachi Province

Natsuka Masaie (d. 1600), an aide of Hideyoshi and a skilled administrator

SUMMARY OF EVENT

The Taikō Kenchi, a nationwide survey (*kenchi*) of land in Japan, was conducted under the mandate of the *taikō* Toyotomi Hideyoshi, the de facto military ruler of Japan. In 1591, Hideyoshi took the title of *taikō* created to refer to the father of the *kampaku*, or chief imperial adviser, when Hideyoshi awarded the position of *kampaku* to his adopted son Hidetsugu. As Hideyoshi's forces conquered territory in a series of campaigns from 1570 to 1590, his regime was faced with the need for a uniform administrative system. One of the most basic



Part of a series of paintings by Katsushika Hokusai (1760-1849) showing different views of Mount Fuji, this picture touches on two central elements of Japanese diet: fish and rice. Two people can be seen fishing, while a man leads a horse carrying rice seedlings to plant in the distant rice paddies. (Library of Congress)

tasks required was a land survey, to determine the exact amount of land Hideyoshi held, the estimated crop (especially rice) yields, and the potential taxes that could be levied on the rice produced.

Feudal rulers of some domains had earlier surveyed land under their control, but varying methods and measurements were used in these scattered surveys. After 1582 until his death in 1598, Hideyoshi conducted a series of uniform land surveys as territories came under his control. Earlier domain surveys were revised to conform to uniform standards and methods. In general, each farming village, together with its surrounding fields, was surveyed as a unit, so tax officials had figures for each village as a whole as well as for individual farms. Distinctions were made between rice paddies and fields growing vegetables, and the number of dwellings was also recorded. Farmers in possession of fields and crops were listed and were held responsible for paying taxes on crop yields. These farmers and their descendants were expected to remain on this land and provide the authorities with tax payments every year.

The surface area and projected crop yield were recorded for each field. The basic units of surface measurement were the *bu* (3.95 square yards, or about 3.3 square meters), the *se* (119 square yards, equal to about one hundred square meters or one acre), the *tan* (0.245 acre, or about 0.1 hectare), and the *chō* (2.45 acres, or about one hectare). Fields were also ranked by arability and apparent fertility into four grades: high, medium, low, and very low. The average yield of a rice paddy was stated in terms of the number of *kyōmasu*, “measuring boxes” full of rice grains, based on the standard measures used in the Kyōto area. Farm taxes were paid in the form of percentages of harvested rice crops, and this local information gave government officials a way to make sure the proper amounts of rice were paid. Bulk rice levies collected were measured in *koku*, a grain measure of approximately 180 liters. Official stipends and salaries were often denominated in *koku* of rice, certificates for which could later be brokered and converted into cash.

The survey information was recorded in *kenchichō*, “survey ledgers.” Two copies of these ledgers were prepared for each village, containing both individual farm survey information and total figures for the village as a whole. These copies were jointly examined and verified by a government official and a designated representative of all the farmers in the village. One copy was kept in the village and the other went to the central government’s tax and accounting officials. Although these ledgers did not always contain totally accurate information regarding the number of farmers required to pay taxes at the time, they do provide important information about rural populations for modern historians.

Hideyoshi took a personal interest in the land survey. In 1573, he defeated forces led by the Asai family, and his overlord Oda Nobunaga rewarded him with the Asai domain in what is now northern Shiga Prefecture, making him a feudal lord for the first time. Hideyoshi conducted a thoroughgoing survey of this new territory, and after gaining control of most of Harima Province (present-day Hyōgo Prefecture) in 1580, he had an extensive land survey carried out there as well.

After Nobunaga’s death in 1582, Hideyoshi became a national warlord in his own right. A series of campaigns resulted in his de facto rule over the entire country by 1590. Starting in the Kyōto area in

1582, Hideyoshi ordered regional land surveys in each territory he conquered, including modern-day Fukui Prefecture (1583), Shikoku and the Kii Peninsula (1585), Kyūshū (1587), and the Kantō and Tohoku regions (1590). Hideyoshi's surveys were conducted mainly under the supervision of three of his leading generals: Asano Nagamasa, Ishida Mitsunari, and Natsuka Masaie.

Much of the land in Japan had thus been surveyed by the time Hideyoshi consolidated control of the country in 1590, but he had a new and more comprehensive nationwide survey planned and implemented. Most of the consolidated survey took place in 1594-1595, and it was known at the time as the Taikō Kenchi, or "Land Survey of the Taikō, Hideyoshi." This term later also came to refer loosely to all the land surveys conducted by Hideyoshi throughout his career. The later, consolidated survey was also called the *koku-naoshi*, or "*koku* revision," because it involved recalculation of the number of *koku* of rice produced and it revised estimates of the number of *koku* to be taken as taxes.

Ishida Mitsunari, a leading military figure and civil administrator under Hideyoshi's command, was instrumental in planning and conducting the consolidated land survey. In 1594-1595, Ishida was in charge of a model survey of territory in Hitachi Province (modern Ibaraki Prefecture), in the Kantō region. The Tokugawa Mito domain in this area subsequently became a model of enlightened administration and efficient farming, which may be partly attributable to the groundwork established by Ishida's survey.

SIGNIFICANCE

Many of the administrative practices and procedures in the following Tokugawa era (1603-1868) were introduced by Hideyoshi. The land survey system is a prime example of this. Prior to Hideyoshi's time, a considerable amount of land in Japan was in the actual or nominal possession of religious institutions, and the crops were used to support a particular Buddhist temple or Shinto shrine. In recurring times of civil disorder and social upheaval, some government officials appointed to administer regional areas came to regard their positions as permanent, and they took possession of large amounts of land as their own property. Hideyoshi's land surveys dramatically changed this ownership system.

By Hideyoshi's time, the Ashikaga shogunate and the Imperial Court had little real authority to grant or assign land to anyone. The last Ashikaga shogun was deposed by Oda Nobunaga in 1573, the same year that Oda made Hideyoshi a domain lord. The warfare carried on by Oda, and then Hideyoshi, cleared the land titles of many large holdings by eliminating the owners, such as the Asai family. These holdings were then given to victorious generals. The nationwide Taikō Kenchi survey system legitimized the taxation rights of Hideyoshi's new central government, identified local farmers, village by village, made them responsible for their own land, essentially bound them to that land, and put them under the authority of assigned village leaders. This nationwide land survey process became the basis for the entire Tokugawa system of taxation and of social control at the local level.

Michael McCaskey

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■ 17TH CENTURY

ENGLAND UNDERGOES AN AGRICULTURAL REVOLUTION

Seventeenth century agricultural innovations included new cropping patterns, intensive and diversified fertilization techniques, extensive land reclamation, and new crops for human consumption and forages for livestock. In conjunction with increasingly complex marketing strategies and evolving industrial activity, these techniques elevated the overall nutritional levels of enlarging Western European populations. In England in particular, a favorable parliamentary environment encouraged this revolution.

LOCALE: England; the Low Countries, particularly the Netherlands
AGRICULTURAL ISSUES: Animal husbandry; Fertilizers; Innovations; Marketing and trade; New crops and food products; Population growth; Scientific research

KEY FIGURES

Francis Bacon (1561-1626), English scientist who was the first to apply science to agricultural concerns, particularly seeds and soil
Nehemiah Grew (1641-1712), English physician and botanist
John Evelyn (1620-1706), English writer and cofounder of the Royal Society
Robert Boyle (1627-1691), Irish chemist and cofounder of the Royal Society

SUMMARY OF EVENT

Nineteenth and early twentieth century historical accounts of the European Agricultural Revolution suggested 1760 as a starting date for the emergence of new agricultural practices. In fact, however, a number of processes—political, scientific, demographic, and economic—had coalesced more than a century earlier, ushering in a gradual institutionalization of new, primarily English, agrarian procedures. All areas of English agriculture were affected, and agrarian evolution proceeded simultaneously with and provided both support and impetus for incipient industrial activity.



Francis Bacon, the first Englishman to apply scientific methods to the study of agriculture.
(Library of Congress)

British scientists were among the first Europeans to use scientific observation and experimentation to investigate the potential for increased agricultural productivity. Francis Bacon initiated the study of soils and seed germination. Robert Boyle also worked on soil chemistry and authored *The Sceptical Chymist* (1661, rev. 1679). In 1662, Boyle contributed to the founding of the Royal Society. Another early member, John Evelyn, wrote the first British monograph on soil, *A Philosophical Discourse of Earth* (1676), while the London physician Nehemiah Grew published *The Anatomy of Vegetables Begun* (1672), by virtue of which he is considered one of the founders of the field of plant anatomy. These men and others, such as John Woodward (1665-1728), whose quantitative studies of plant physiology provided a basis for an understanding of plant nutrition, provided literate landowners with a comprehensive history of agricultural accomplishments, and their analyses made clear what other advances would be necessary before higher crop yields could be realized.

The English Civil Wars (1642-1651) allowed certain Royalist landowners to travel to the Low Countries, where varied farming and land

reclamation practices were observed and ultimately imported to Britain. New crops in rotation and nitrogen-fixing plants were described in publications such as Walter Blith's *The English Improver Improved: Or, The Survey of Husbandry Surveyed* (1653). Multiple techniques were utilized by English farmers, including increased tillage, drainage, irrigation, and higher levels of manuring.

England's agricultural community profited from government support in the seventeenth century. After the Restoration of Charles II in 1660, Parliament included several influential members of the landed gentry who favored legislation that promised to enhance agricultural profit and productivity. The Corn Law of 1670 provided for duties on imported wheat to be determined by local pricing of English wheat. The Corn Bounty Act (1688), on the other hand, subsidized corn exports.

A series of parliamentary acts beginning in 1604 allowed for the creation of enclosures, that is, the physical enclosing of agricultural land with fences or hedges, thereby amalgamating previously community-controlled holdings into larger, privatized, profit-oriented enterprises. Gradually, new crops and cropping patterns appeared, as did greater numbers of animals, which enhanced soil fertility. Animal numbers in pre-enclosure times were limited by the availability of common-use pastures. Enclosures created more acreage for experimentation and gradually divorced farmers from ancient, community-oriented practices. Thus, the Agricultural Revolution altered England's rural social structure and land-use patterning, while increasing the supplies of food.

Incremental improvements and introductions defined the seventeenth century Agricultural Revolution, rather than mechanical breakthroughs. The enduring achievement of the century was the realization that livestock and cereal agriculture could be united by introducing new crops such as turnips, clover, and grasses. The new crops coupled with new tillage practices raised outputs, elevated soil fertility, and complemented labor and cultivation inputs.

The seventeenth century witnessed more land under the plow, a positive remedy for both weedy fields and certain livestock diseases. Gradually, a tillage revolution came about whereby formally permanent grassland and inconsistent cultivation were replaced by up-and-down husbandry, that is, the plowing and sowing of new grassland.



Turnips were one of the most important crops in seventeenth century England. (Library of Congress)

After several years of grazing or harvesting, the process was repeated. Hence, a rotational system replaced the medieval multifield pattern. Upon the grass, sheep and beef cattle were fattened, while milk and butter were produced in dairy areas. Greater supplies of animal forage meant that larger numbers of animals could be kept through the winter, thereby increasing supplies of manure as well as raising farm profits through new marketing strategies.

Industrial crops were grown experimentally, and then, if they proved successful, their culture was intensified. Woad, a dye crop, was extensively grown between 1590 and 1660. A by-product of the woad plant could be fed to sheep, so woad provided numerous benefits, including forage, ready cash through industrial sales, and a rationale for increased tillage. Additional crops destined for industrial usage included hemp, flax, and hops. Fertilized grassland provided up to four times the nutrients available in old common-use pastures. Forage productivity during the seventeenth century allowed livestock numbers to quadruple. Increased livestock numbers ultimately channeled more products into the industrial community, which in turn could provide those products, such as tallow, horn, and hides, more efficiently to existing markets, as well as developing new markets.

Wool, long an important British product, was selectively altered during the seventeenth century to create a coarser type, destined for worsted cloth.

Soil fertility was a major concern of the agrarian program—manure, both animal and green manure, was liberally applied to the fields. Lime and marl, and any degradable material—bone, rags, ashes, chalk, and industrial wastes—were hauled to crop fields and tilled in.

Some farmers fattened sheep; mutton production rose. Others fed cattle or hogs on grasses, grains, and forage by-products. Marketable field crops included mustard, peas, beans, barley, lentils, carrots, peas, tobacco, and potatoes. Acreage devoted to English tobacco increased throughout the seventeenth century. Potatoes, previously grown in the sixteenth century for household usage, became an important crop for the cattle feeder by 1650. Turnips, initially a household root-crop, became a desirable crop for the cattle feeder and dairy farmer after 1660. By 1720, turnip cultivation accounted for about 8 percent of all tilled acreage. In the following century, the politician and agriculturalist Charles Townshend, second Viscount Townshend of Raynham (1674-1738), popularized the use of turnips as winter fodder and championed the four-course rotation system.

SIGNIFICANCE

The seventeenth century witnessed the dawn of specialization in English agriculture. Dairy farming, cattle feeding, industrial cropping, and sheep farming all appeared as specialties or as components in diversified farm operations. Market gardening of fruits and vegetables enhanced the profits for farmers living in proximity to growing urban areas. Population growth in England was yet another force that affected agricultural innovation: The 1540 national population of 2.8 million had enlarged to 5.2 million by 1650. In London as well, population growth mirrored the rise of nonfood producers; a population of 60,000 in 1534 rose to about 530,000 by 1696.

The challenge to achieve higher levels of agricultural efficiency was singularly addressed by England and Holland. The benefits of their innovations were legion. Foremost among these was a more balanced and nutritious diet, available not only to urbanites but to rural folk as well. Vitamin and caloric intake rose appreciably as the year-

round availability of eggs, fruit, cereals, vegetables, and red meats, in addition to preserved foods, became commonplace.

Arable land benefited from increased fertilization practices and drainage. Land reclamation, ongoing since the Middle Ages, accelerated during the seventeenth century. Wetlands and fens were drained, and inland canal systems were improved, which in turn facilitated proto-industrial activity. Dutch engineers aided English landowners in technique; however, the revolution was largely an internal process, employing English resources and ingenuity and reinterpreting traditional and emerging problems.

The product of these labors was a more scientific, more productive form of agriculture. In the next century, mechanization would become widespread in planting and harvesting equipment.

Rene M. Descartes

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■ 17TH CENTURY

EUROPE ENDORSES COLONIAL ECONOMIES BUILT ON SLAVERY

By the seventeenth century, slavery had been absent from European soil for four hundred years. However, the reemergence of slavery in the New World forced Europeans to decide between condemning and condoning a practice that was as economically desirable as it was morally inexcusable. Europe's endorsement of New World slavery ensured that the colonies' primarily agricultural economies would be built on the institution.

LOCALE: Europe, the Mediterranean basin, and Africa

AGRICULTURAL ISSUES: European colonization; Labor; Marketing and trade; Slavery; Tropical produce

KEY FIGURES

Charles II (1630-1685), king of England, r. 1660-1685

Louis XIII (1601-1643), king of France, r. 1610-1643

Urban VIII (Maffeo Vincenzo Barberini; 1568-1644), Roman Catholic pope, 1623-1644

Jean-Baptiste Colbert (1619-1683), French controller general of finance, 1665-1683, minister of marine, 1669-1683, and secretary of state, 1669-1683

SUMMARY OF EVENT

Economic realities had essentially forced slavery out of Europe by the thirteenth century. Over the next four hundred years, however, as maritime advances opened up fresh sources and new markets for products, the preoccupation of European leaders with their intercontinental disputes and wars allowed for the reestablishment of the trade in human beings, this time in the Americas. The unique situations of colonial America and Africa made slavery not only feasible but also economically desirable, while the authorities in Europe were both slow to react against the creation of a global slave trade and impotent to regulate affairs on the other side of the world once they attempted to restrain the trade.

The institution of slavery goes back to the beginning of recorded history, but slavery faded in Europe between 800 and 1200, transitioning into feudalism. The latter system used serfs, who had some limited rights, instead of slaves, who were treated only as property. The absence of slavery in Europe had lasted a couple of centuries, when, once again, the potential profits of trading in forced servitude attracted Europeans. Portuguese mariners of the fifteenth century transformed the limited intra-African slave trade into an intercontinental market. Other Europeans followed suit, including the Spanish (1479), the English (1562), the Dutch (1625), and the French (1634).

The European hunger for sugar and to a lesser degree that for coffee, chocolate, and tobacco fueled the rise of slavery in the New World. The capture and deportation of generations of Africans was from the outset founded on the economics of gold. By the seventeenth century, it was a simple white substance that caused the stir. Sugar held two strong attractions: Economically, it was valuable enough to gain the label “white gold,” and physically, it was almost addictive. The Arabs had taught the Crusaders how to cultivate sugar on plantations around the Mediterranean. When it was brought back to the West, European consumers came to associate sugary products with wealth, increasing demand by imparting it with symbolic value in addition to its more obvious use-value. As a result, what had been profitable to cultivate at the edges of the Mediterranean became hugely valuable when installed in the tropical areas of the New World. From the middle of the seventeenth century to the middle of the eighteenth, sugar outdistanced grain as the world’s most valuable commodity.

The Dutch demonstrated the profits that could be made from a wide range of associated commercial operations. In the port of Amsterdam, they built sugar refining and warehousing companies to complement the shipping industry. The three-stage journey required to provide “sugar in every cup of tea” began in seaports from Spain to Denmark. Ships left these ports bound for the west coast of Africa, where, with the help of African middlemen, the Europeans traded manufactured goods (especially guns) for slaves. Captive Africans were then taken to the Americas and exchanged for raw sugarcane. The cane was shipped to Europe for refining, thereby completing the commercial triangle. Entire cities, especially the ports of Seville, Lis-

bon, La Rochelle, Amsterdam, and London, profited enormously from this system.

The cultivation of these tropical crops relied upon two essential components: large expanses of land and large numbers of workers. In order to take advantage of innovations in seafaring and international trade, European nations organized legitimate commercial companies. These enterprises, often labeled with exotic names, ended up providing slaves to American plantations. In 1621, the Dutch formed the West India Company, which by virtue of its government-granted monopoly became one of the largest single slave-trading businesses in history. In 1660, King Charles II of England supported the launch of the Royal Adventurers into Africa. Twelve years later, the British created the Royal African Company, which set up and administered trading posts in western Africa. One task of this organization was to seize the occasional rogue British trader who, for private gain, tried to bypass the royal monopoly. Privateers and pirates also did their share of slave trading during this century.



England's King Charles II.
(Library of Congress)

Seventeenth century monarchs played an important role in deciding whether to move toward or away from slavery. The favorable economics of the enterprise usually outweighed moral considerations among European leaders. King Louis XIII of France was at first aghast that the refined French should follow Portugal and Spain in accessing the slave trade. Eventually, however, led by the promise of national profit and convinced that the Africans would benefit by converting to Christianity, the French became willing participants in human commerce. Jean-Baptiste Colbert, Louis XIV's finance minister, doubled national revenues over a ten-year period. One of his profit points was the establishment of France's own West Indian Company in 1664, complete with contracts for the delivery of slaves to the New World.

Most seventeenth century European heads of state were too worried about their own domestic or intercontinental disputes to involve themselves with the issue of slavery. The French, for example, fought among themselves in the Siege of La Rochelle (1627-1628) and battled the Spanish off and on between 1635 and 1659. Louis XIV went to war (1667-1668) against the country of his wife, Marie-Thérèse, daughter of Philip IV of Spain, in order to gain territory. The English, the Irish, and the Scots fought between the years 1641 and 1648. The Thirty Years' War (1618-1648) included a Danish phase (1625-1629), a Swedish phase (1630-1635), and a Franco-Swedish phase (1635-1648) before the Peace of Westphalia (1648). Thus, if the distracted European governments addressed the question of human servitude, they generally pronounced against it but then supported it indirectly by enacting trade motivations.

The positions of religious institutions vacillated on the question of slavery. The idea of bringing indigenous people a new and "right" religion was used to justify the subjugation of Africans. However, religious currents were usually a force *against* slavery, or at least for the mollification of its fierceness. In 1627, Father José de Anchieta, a Jesuit priest working peaceably among the Indians of Brazil, faced off with his compatriot colonizers who wanted to import slaves. The Jesuits in that same year announced to Europeans their belief that slavery combined humankind's worst qualities. In 1639, Pope Urban VIII forbade slavery in any New World colonies. Exemplifying the ambiguity of the time, the Quakers in 1676 admonished others to "treat kindly" their slaves and yet banned "negroes" from their own meet-

ings. Further, the Roman Catholic Church, despite its official anti-slavery message, had a history of being associated with properties worked by slaves.

The Europeans received their first impressions of Africans by way of explorers' journals and various tales of travel. Along with missionaries, adventurers and often slavers wrote about their encounters with Africans. Thomas Phillips, a British slave trader of the late seventeenth century, admired "Negroes" who willfully drowned themselves rather than submit to slavery. Of all the original European perceptions of African peoples, the one that continued to prop up the system of brutality was the idea that the black man had a special resistance for working the hot and humid fields of sugarcane. Despite the obstacles of disease and oppression, and despite dying in shocking numbers, slaves did produce tropical crops in profitable quantities. The Europeans did not lose sight of this fact.

SIGNIFICANCE

Even apart from the mass genocide that results from the transport and abuse of slaves, slavery represents humankind at its worst. Many modern culture clashes have their roots in the transatlantic slave trade. Seventeenth century Europe, itself free from slavery for many years, became its instigator on the world stage, essentially for profit motives. Leading up to the seventeenth century, maritime and other technological advances made international slaving economically feasible on a large scale. Sea explorers were more intrepid and precise in their undertakings because of better ships, maps, and clocks.

Even if slavery had its historical origins already in place among African tribes, it never would have developed into the mass removal of peoples across the Atlantic without European technologies of agriculture and transportation and European political and social structures underpinning those technologies. If one considers that the institution of slavery was on the brink of extinction in the Western world, Europe's culpability in the foundation of the transatlantic slave trade becomes even clearer. It seems possible that some little impetus from a leader here or there might have been sufficient to prevent the trade from taking root and to allow it to progress toward obsolescence.

Steven Crawford

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■ 17TH CENTURY

PEPPER TRADE DRIVES THE GLOBAL ECONOMY

The rise and fall of the global economic system in the seventeenth century is directly connected to the production and distribution of pepper, which linked Southeast Asia to important markets in Western Europe, East Asia, and the Mediterranean. Pepper was a much-needed spice, used for food preservation as well as for masking the taste of spoiling food.

LOCALE: Southeast Asia

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Marketing and trade; Tropical produce

KEY FIGURES

Elizabeth I (1533-1603), queen of England, r. 1558-1603, who chartered the British East India Company

Jan Pieterszoon Coen (1587-1629), a director of the Dutch East India Company

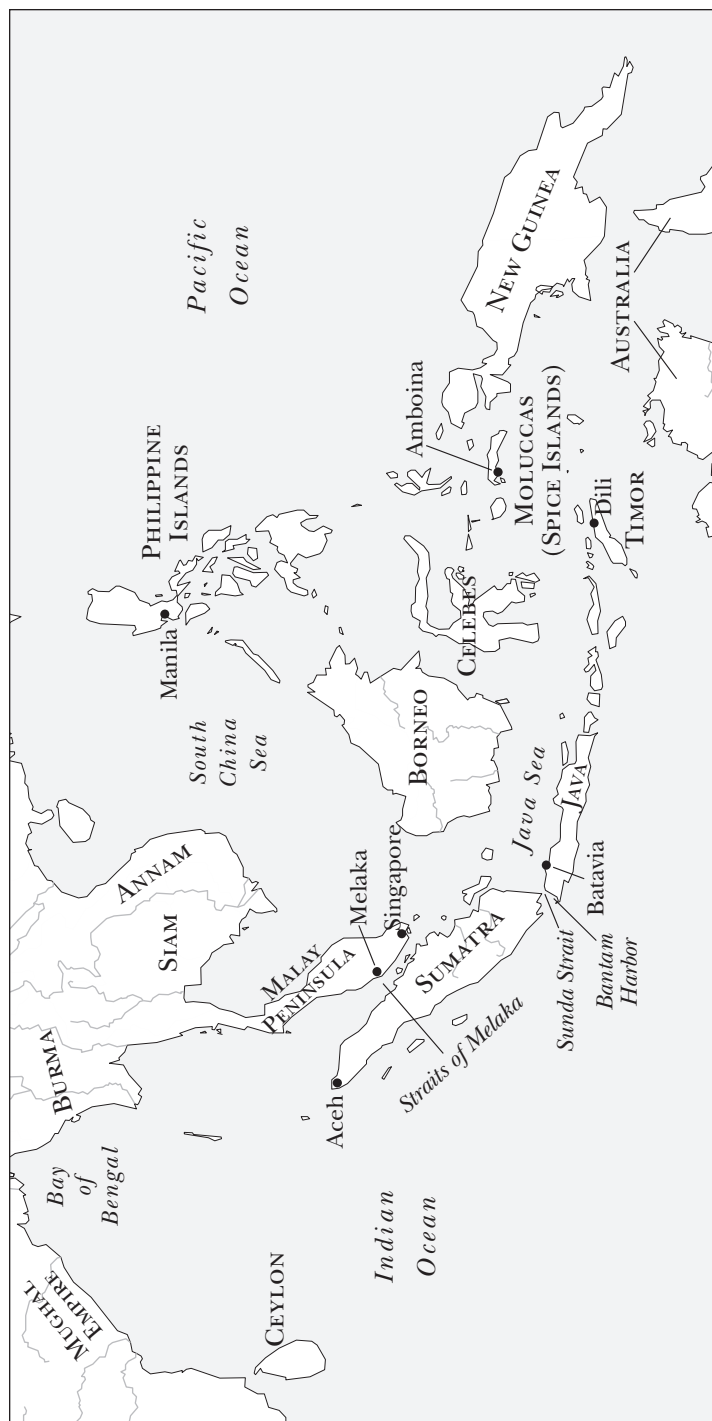
Tokugawa Ieyasu (1543-1616), shogun, r. 1603-1605, who organized and regulated Japan's Southeast Asian trade

SUMMARY OF EVENT

No other agricultural product had the vast market appeal of pepper. It became the first international cash crop purposely cultivated for world consumption. The sale of this important resource accelerated the expansion of the Southeast Asian economy, providing thousands of jobs and increasing the standard of living across the region. It was the foundation of the Southeast Asian sector of the new world economic order.

In an age without the ability to preserve food, spice, especially pepper, dominated the culinary world of early modern Eurasia. Combinations of spices could be used to preserve vegetables and meats and could also mask the unappetizing taste of food that was beginning to spoil during an era long before refrigeration was invented. Pepper was the basic ingredient in most of these mixtures, thus allowing it to occupy the position at the top of the spice hierarchy.

SOUTHEAST ASIAN TRADING REGION



China became involved in the pepper trade during the early years of the Ming Dynasty, when the country was able to establish a dominant position in the Indian Ocean complex. This newfound power helped energize the expansion of the Chinese economy and coincided with the introduction of large amounts of silver from mines in the Americas and Japan. This unprecedented economic growth led to a significant increase in the Chinese population. This in turn created a greater demand for the production of pepper, which was a major ingredient in Chinese cooking. Pepper would eventually become the first product of mass consumption in Chinese history.

Growth in the Chinese market also expanded the cultivation of pepper in the nations of Southeast Asia. This increased production and the wealth it generated affected every aspect of Southeast Asian society. Most of the region witnessed an increase in employment opportunities; this allowed people to marry earlier and have larger families, which triggered the growth of other sectors of the region's economy. The pepper trade also led to the migration of Chinese merchants to Southeast Asia, especially to Indonesia. Eventually, these entrepreneurs would become a dominant force in the region. This expanded Chinese presence was accompanied by neo-Confucian thought, which would play an important role in the creation of the bureaucratic sector of the new, powerful, highly centralized governments that came into existence in response to the need for the regulation and protection of the trade in pepper.

This global economic upturn also fostered urbanization in both China and Southeast Asia. Cities usually grew up around important ports and quickly became vibrant economic and cultural centers. Most of the cities supported not only educational institutions but also artists who were drawn to these locations because of their energy, freedom, patronage, and multicultural populations.

China also faced competition from the Islamic world. Fleets from Dar es Salaam maintained a powerful presence in the Indian Ocean and were part of a trading complex that extended to the Red Sea and the Persian Gulf. Originally the Mamlūk Empire, and eventually the Ottoman Empire, controlled both the sea lanes and the caravan routes that dominated the pepper trade in the Mediterranean region.

Like the Chinese experience, the Islamic participation in the pepper trade stimulated the migration of merchants to Southeast Asia. From the very beginning, Islam made great headway in the region, converting thousands of Southeast Asians to the Islamic faith. This was especially true among the merchant class, which favored a belief system that was open to international commerce. Muslim missionaries emphasized the fact that the Prophet Muḥammad came from a family of merchants in Saudi Arabia. The ethical teachings of Islam concerning commercial transactions also played a major role in the economy of Southeast Asia.

In addition, Europeans were attracted to the potential economic power of the pepper trade. The Portuguese broke the Chinese-Islamic monopoly when they gained control of the Indian Ocean. The Portuguese used their new, sophisticated marine and military technology to control the sea lanes by initiating oceanwide search and destroy missions, engaging and defeating the navies of both China and the Islamic world.

Other Atlantic states eventually would begin to compete for a share of the lucrative trade in pepper; the two most successful states were Great Britain (British East India Company) and the Netherlands (Dutch East India Company). Both nations were part of the European commercial revolution, which rested upon a triad of great trading companies, a strong and reliable banking system, and centralized, government economic planning. The move by the English and the Dutch into this global competition was accomplished by the formation of two powerful joint stock companies that focused on gaining control of the East Indian trading network. Both institutions were given unlimited government support and were allowed to initiate and conduct diplomatic and military operations. Both nations were willing to give these companies almost unlimited military support while allowing investors to make substantial profits from their trade.

In 1600, Queen Elizabeth I of England granted a charter to the British East India Company, giving it exclusive rights to trade in Asia. The company's initial success came from the substantial profits it made in the trade of pepper. Directors used this capital to increase the size of their fleet, which allowed them to expand the scope of their power. The Dutch followed suit in 1602 with the creation of the



England's Queen Elizabeth I.
(Library of Congress)

Dutch East India Company, and under the leadership of Jan Pieterszoon Coen the company made significant inroads in the region. Coen adopted an aggressive policy of colonization along with enforcing strict monopolistic control over the sale of pepper. By the early seventeenth century, England and the Netherlands controlled a substantial portion of the pepper trade.

Japan, too, played a major role in this new world system. Many historians mark this period as the start of the ascendancy of early modern Japan. The need for the regulation and protection of the pepper trade helped solidify the legitimacy of the newly established Tokugawa shogunate. Under the early leadership of Tokugawa Ieyasu, the new dynasty not only regulated the number of merchants that could take part in the trade but also created a powerful navy to protect its merchant fleet.

In turn, this stimulated the growth of Japan's urban sector. New

cities became centers of Japanese commerce, and the merchant families located there grew in power and influence in the first half of the seventeenth century. This massive expansion of Japanese trade also was driven by the substantial increase in the nation's production of silver, which was used to purchase pepper from Southeast Asian plantations.

The steady increase in the price of pepper that helped create the prosperity of the late sixteenth century peaked and began to decline in the third decade of the seventeenth century. One of the major factors that contributed to this economic decline was the reduction in the quantity of silver that entered the world system from the mines of Latin America and Japan. This lack of purchasing power led to a decrease in the demand for pepper, which in turn affected other areas of economic activity in the global economy.

Urban areas and the merchant class that dominated the trading system were especially hard hit, and port cities throughout the Indian Ocean complex experienced dangerous levels of civil unrest. This political and social chaos manifested itself in the revolutionary activity that traversed the entire Eurasian landmass, from the Ming Dynasty in the east to the British Isles in the west. This was particularly true in Southeast Asia, where this systemic shock reduced the standard of living, which accelerated a decline in both urban and rural areas. The new centralized governments that drew their strength from the regulation of the pepper trade lost much of their power and control. No other area of the world economic system suffered to the extent of Southeast Asia, and it would be centuries before the region would recover from this terrible calamity.

SIGNIFICANCE

The decline and virtual collapse of the Southeast Asian pepper trade was both a characteristic and a catalyst of the economic crisis of the seventeenth century. The hemispheric economic unsteadiness increased competition for control of a rapidly shrinking market. Most of the major nations would, in the end, use military force. The advanced technology possessed by the European states would allow them to dominate the armed forces of their competitors, and this moved the European nations into a position of prominence in the region.

In Asia the economic chaos hastened the collapse of the Ming Dynasty. It also sapped the once powerful states of Southeast Asia of their energy and pushed them into three centuries of impoverishment and colonial control.

Richard D. Fitzgerald

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■ 17TH CENTURY

RISING PROTO-INDUSTRIAL ECONOMIES DRAW WORKERS FROM FARMS

Prior to the Industrial Revolution in the eighteenth century, Europe's population became largely accustomed to the conditions of manufacturing labor through work in peasant homes and small villages where the workers derived their support from wage labor.

LOCALE: Primarily western Europe

AGRICULTURAL ISSUES: Labor; Subsistence agriculture; Textile industries

SUMMARY OF EVENT

The idea of proto-industrialism was advanced by scholars after World War II. The general outline of the concept was presented in an article by Franklin Mendels, a professor at the University of California at Berkeley, in an article published in the *Journal of Economic History* in 1972. In his article, based on his study of cottage manufacture in Belgium from the sixteenth to the eighteenth century, Mendels argued that the foundation of the Industrial Revolution of the eighteenth and nineteenth centuries lay in the creation of a laboring population accustomed to deriving its support not from agriculture but from manufacturing work in small shops and peasant homes. These sites existed in areas where the land was insufficient to support all those who lived in the area, either because the quality of the soil was not well suited to raising traditional crops or because the supply of good land was simply too restricted to support a large population.

Mendels supported his argument with some statistics derived from information about population in the area of Belgium south of the city of Ghent. This study suggested to Mendels that there were certain characteristic features of areas in which proto-industrialism took place. These included a fairly rapid increase in the population and the sale of manufactured goods on the international market. In the case of the area cited by Mendels, the manufacture of linen textiles was the defining feature, though he noted that although pop-

ulations rose significantly in these areas, there was no discernible improvement in wages. At the same time, agriculture became increasingly commercialized, requiring large labor inputs only for short periods, so that a laborer could not rely solely upon such work to support a family.

Mendels's argument was picked up by historians in Europe, some of whom saw the concept as supporting the arguments of Karl Marx that the growth of an impoverished class of wage earners was an inevitable accompaniment of industrialization. Marx, indeed, had advanced a distinct but closely related argument to that of Mendels when he wrote that the "violent expropriation" of workers from the land was a necessary precondition of the Industrial Revolution, because it had created a large pool of potential unskilled laborers in urban centers, which alone made assembly-line manufacturing economically feasible. Whereas Marx looks at the issue from the point of view of the growing migration of former peasants from farmlands to urban areas, Mendels emphasizes that even the relatively rural pockets of proto-industrialization that developed in the seventeenth century provided a pool of workers already accustomed to working for wages barely above the subsistence level and therefore made the growth of factories in the eighteenth and nineteenth centuries easier.

Proto-industrialization is similar in important respects to what was once referred to as "cottage industry." Under this system, individual peasants who lacked sufficient land to support themselves through agriculture alone supplemented their income with small-scale manufacture, usually of textiles and often in their own homes. The early textile devices were very simple and inexpensive, so a peasant could easily afford, for example, a spinning wheel or even the simple looms common in the seventeenth century. Much cottage industry production consisted of turning common European fiber, either wool or flax, into textiles. With the growth of sheep raising in England, it became worthwhile for rural laborers to convert the wool first into yarn and then into woolen fabrics.

One common feature of the cottage industry was that it almost invariably occurred in the countryside. A major reason for this location was that, in many European towns in the seventeenth century, the guilds that had grown up during the Middle Ages still largely controlled manufacture; their authority, however, did not in most cases

extend to the countryside outside the towns. Production outside towns was therefore not subject to the urban limitations imposed by the guilds to protect their economic position.

Historians differ over whether seventeenth century proto-industrialization can be seen as a consistent transitional step along a steady, systematic path of industrial evolution from the household manufacture of the late Middle Ages to the Industrial Revolution of the eighteenth and nineteenth centuries. Research has demonstrated, for example, that population growth was encouraged as much by such things as the international trade in basic grains that emerged in the sixteenth century and the cost of living fluctuations related to that trade as by the opportunity to earn a living from wage labor. The specialization of agriculture, moreover, had as much to do with the variable productivity of the soil as with the existence of alternative means of support for a burgeoning population, and it was found that in some areas, where early cottage industry existed, changing commercial relations could also lead to de-industrialization.

The two industries in which examples of proto-industrialization were most prevalent were textiles and mineral production. As agriculture became less generalized and the raising of sheep became common in England in the fourteenth century, the crop the sheep produced, wool, was at first largely exported to the Low Countries and Italy. English production at first focused on the cities, where it was controlled by the guilds, but in the sixteenth century, production shifted away from the cities to the countryside. Woolen yarn and then textiles came to be produced in Yorkshire, East Anglia, the West Country, and even the southwest. In central England, hosiery knitting became extremely popular, because, although it was labor-intensive, it did not require much skill and therefore lent itself to the type of household industry that was characteristic of the earliest kinds of proto-industrialization.

In addition to the development of English proto-industrial textile manufacturing, small mining operations were also scattered over the English countryside. These operations produced iron, lead, and tin—the latter notably in Cornwall. The Kentish Weald was dotted with small iron furnaces in the seventeenth century, and in Derbyshire lead mining was common. In the West Midlands, many small metal objects were produced in modest shops, notably in Sheffield

and Birmingham, areas that remained major producers of metal products in subsequent centuries.

The history of textile production in parts of the Low Countries was what led Mendels to develop his theory of proto-industrialization. While the area of modern Belgium had been known since the early Middle Ages for its woolen textiles, by the seventeenth century, it was more widely known for its linen goods. The flax that produced the fiber that was the basis of linen was grown throughout the Low Countries, and when agriculture became concentrated in the better lands, the peasantry living where the soil was less suited to commercial agriculture began to specialize in flax and linen production. Mendels found, in the area around Ghent, excellent examples of small-scale production of textiles, often in the homes of the workers; his concept, then, was a generalization of his study of this specific area.

Linen production was also found in many areas of what is now Germany. In parts of the Rhineland, particularly Silesia, there were numerous villages where the flax fiber was treated (a labor-intensive process) and then spun into linen yarn. The yarn was then passed on



Russian workers harvesting flax, long an important source of fibers used in textiles.
(Library of Congress)

to the linen weavers, who enjoyed an international reputation. In the Swiss canton of Appenzell Outer Rhodes, the production of linen goods was widespread, since the mountainous countryside did not lend itself to raising crops. In the vicinity of Basel, there were households busily producing silk ribbon in the seventeenth century. In some areas, ownership of small agricultural plots was combined with textile production, as in the Oberlausitz region.

In Italy, where woolen textiles had been a major industry during the Middle Ages, production had shifted to silk by the seventeenth century. Silk was produced in the parts of Europe with a Mediterranean climate, especially in southern France and northern Italy. The combination of silkworms and mulberry trees, native to that region, was essential. Raising the silkworms to a level where the silk filaments could be captured and converted to thread was a labor-intensive business that was widespread in northern Italy and southern France. Woolen goods, which had been produced in the major Italian cities during the Middle Ages, became a cottage industry in the seventeenth century, particularly in the valleys of the lower Alps.

There were, also, many small producers of iron in the northern Italian valleys in the seventeenth century. Because the mountain streams provided sufficient water power to operate the bellows used in smelting the iron, the necessary ingredients were locally available. In the seventeenth century, metallurgical technology still allowed for small-scale production without heavy capital investments. Even as the technology came to call for greater investment, it still needed abundant producers of charcoal.

In Russia, where there were few towns, the production of manufactured goods necessarily took place in the countryside. As serfdom spread throughout the country, however, much cottage industry developed under the sponsorship of large landowners, although in some areas the produce of such enterprises was shared by owners and workers. The latter arrangement represented a logical extension of the not uncommon sharecropping used in agriculture to the rudimentary manufacturing industry that was just beginning to emerge.

SIGNIFICANCE

The notion of proto-industrialization was an attempt to develop a comprehensive model that would explain how a world that had been

overwhelmingly agricultural for so many centuries came within a single century or so to be predominantly industrial. By suggesting that industrialization as it developed in the eighteenth and nineteenth centuries had deep roots particularly in the seventeenth century, the proponents of proto-industrialization theory offered historians a seamless picture of the gradual conversion of working lives from ones spent in the field to ones spent first in the rural workshop and then in the factory.

Further research has shown the simple, steady evolutionary version of the concept to be too neat, however. Many places that had thriving cottage industries did not become industrial centers when the technology changed. In some cases these regions became depopulated when other requirements of the industry compelled its location in urban areas. Thus, although the theory of proto-industrialization is appealing as a way of understanding the developing economies of seventeenth century Europe, reality often refuses to be stuffed into a single paradigm. Nevertheless, while the changes predating the eighteenth century may in fact have been uneven and inconsistent, theories such as those of Mendels and Marx are important, because they help to illustrate the extent to which the advent of the Industrial Revolution was simply not possible until significant prior demographic and lifestyle changes had already occurred within the European population.

Nancy M. Gordon

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CHINA BEGINS SHIPPING TEA TO EUROPE

The introduction of tea as a commodity from China into seventeenth century Europe had far-reaching social, physical, and economic consequences. It led to the development of a “tea culture” that shaped social interactions throughout polite society in Britain and elsewhere, and it became a major source of revenue for nations that imposed a special tax upon the new commodity.

LOCALE: China, India, Europe, American colonies

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Marketing and trade; New crops and food products

KEY FIGURES

Catherine of Braganza (1638-1705), queen consort of England, r. 1662-1685, and regent of Portugal, r. 1704-1705

Giovanni Battista Ramusio (1485-1557), Venetian diplomat and author

Oliver Cromwell (1599-1658), lord protector of England, 1653-1658

Peter Stuyvesant (c. 1610-1672), director-general of New Netherland, 1647-1664

SUMMARY OF EVENT

Although by the third century C.E., the benefits of tea drinking were well documented in China, tea did not become popular in Europe until the seventeenth century. The first European reference to tea (also called *chai*) appears in Venetian diplomat Giovanni Battista Ramusio's *Delle navigationi et viaggi* (1559; of the voyages and travels), while the first ship known to have brought tea to Europe arrived from Macao around 1609. The ship's port of origin is uncertain, but it may have been Dutch. By 1615, the English were aware of tea, as it is mentioned in a letter from June 27 of that year written by Mr. Wickham, an agent of the East India Company, and sent from Japan to Macao.

First referred to in England as “cha” (from a Cantonese slang term for the beverage), the drink's name changed later to “tay” or “tee”

when the British changed trading locales from Guangzhou (Canton) to Xiamen (Amoy), where the word for tea is *te* (Wade-Giles, *t'è*). In 1662, tea was still so uncommon in England that when Portugal's Catherine of Braganza arrived at Portsmouth to marry King Charles II, a cup of tea could not be found. The new queen's predilection for tea, however, soon transformed it into a sensation at the English court, and the English affinity for tea increased substantially over time. Between 1650 and 1700, tea imports to Britain totaled only 181,545 pounds, but during the next fifty years, Britain would import 40 million pounds. The Netherlands would also import large amounts of tea in the eighteenth century, consuming by 1770 almost two-thirds as much as Britain. Moreover, from the day that Peter Stuyvesant first brought tea to the Dutch settlement of New Amsterdam, tea consumption also developed rapidly in the British colonies in America.

Drinking tea became a social activity, and as a tea culture developed in Europe, that culture provided a context for social interaction, especially between the sexes. British men cultivated business and literary connections in coffeehouses, sites believed to be less morally objectionable than alehouses or other public gathering places. Women, conversely, acted as hostesses to create gathering places in their private homes, and the tea table became a center of this domestic space. The originally Chinese drink was to become the British drink par excellence, and the tea table and the ritualized ceremony surrounding it were to define British civility, refinement, and family togetherness.

Far from a mere pastime, tea drinking acquired a set of formal, socially coded interactions that provided participants with opportunities both to display and to confirm their social status. By 1732, families and friends would spend social evenings out dancing, listening to music, or watching fireworks at new entertainment venues known as tea gardens, the most popular being Vauxhall or Ranelagh in London. In these popular tea gardens, men and women could meet and take tea together or take in the amusements accompanying the "tea craze."

Beyond its social functions, tea improved the health of Europeans, as it had helped the Chinese for many centuries. Originally introduced into Europe as an exotic medicinal agent said to relieve head-



In 1773, American colonists protesting the British tax on tea imports, disguised themselves as Native Americans, boarded British ships in Boston Harbor, and threw thousands of pounds of tea overboard. The event was afterward known as the "Boston Tea Party." (Library of Congress)

ache and indigestion, tea provided an alternative to alcoholic drinks. Because water was often unsafe, beer and wine were served with most meals, even to children. Tea became a safe, nonalcoholic beverage, since, whether they knew it or not, Europeans sterilized their tea water by boiling it.

During the seventeenth century, tea also became a powerful economic factor by providing large sources of government revenue. From the first arrival of tea in Europe, taxes on tea provided a means of enriching the royal coffers. Oliver Cromwell was the first to tax tea, and in 1660, the Restoration court imposed a tea tax as well. From an exotic luxury, tea quickly became a mass-produced staple commodity, and it came in time to account for one-tenth of British tax revenue. By the middle of the eighteenth century, the tax on tea had



Asians harvesting tea in a terraced field. (PhotoDisc)

grown to 119 percent. However, by 1684, the extreme expense of legitimate, taxed tea created a black market for the drink, and smuggling became widespread.

SIGNIFICANCE

The introduction of tea as a commodity from China into seventeenth century Europe had far-reaching social, physical, and economic effects. In addition to creating new cultural practices and giving Europeans new ways to interact, tea provided a major new source of revenue for the British government and trade in tea helped to forge important diplomatic relationships between the East and the West.

The complexity of importing tea from China to Europe, however, ultimately created a need to grow tea in other areas of the world. When the nineteenth century saw an imbalance of trade between Britain and China, the East India Company began to pay for its tea with opium grown in its India colonies and smuggled to China in the company's ships. This situation led to the Opium Wars of 1839-1842. When these wars depleted the tea supply from China, Britain esca-

lated its tea imports from Assam, India, where tea originally grew wild. Tea was also grown in Ceylon (Sri Lanka) from 1867 and in Africa from the late nineteenth century. By 1900, there were four thousand estates growing tea in India and two thousand in Sri Lanka. Tea consumption also increased the demand for the sugar grown on American plantations, which in turn increased the demand for slave labor on those plantations.

Caffeinated tea would also contribute to the rise of capitalism by becoming an invaluable drink for urban factory workforces during the Industrial Revolution. Inexpensive and nonalcoholic, when mixed with sugar, it provided nutritional sustenance for those working long hours in factories. In addition, tea later played an important role in the nineteenth century temperance or “teetotal” movement’s fight against alcohol abuse, with tea meetings emerging as a means to convert drinkers to sobriety.

Among the most well known of tea’s unpredictable effects on Western history is the role it played in the advent of the American Revolution. The Townshend Revenue Act, passed by Parliament in 1767 on Britain’s American colonies, led to a protest meeting in Boston that culminated in the adoption of a nonimport agreement. In 1773, colonial merchants loyal to the British crown were granted the right to sell tea without paying the tax. However, this agreement merely eliminated the colonial middlemen and passed the cost on to American consumers.

The New England colonists rebelled against the tea tax imposed upon them without their consent, and angry patriots who called themselves the Sons of Liberty disguised themselves as Native Americans and boarded East India Company ships at Griffen’s Wharf on December 16, 1773, where they threw 342 chests of tea from the London firm of Davison and Newman into Boston Harbor. The event, which in time came to be known as the Boston Tea Party, was organized by Samuel Adams with support from John Hancock and led by the wealthy Boston merchant Lendall Pitts. Silversmith Paul Revere also participated. As a result of the Boston Tea Party, King George III closed the Boston harbor, and royal troops occupied the city. The colonial leaders came together to resist the occupation, and the American Revolution was underway.

M. Casey Diana

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TOBACCO FARMING BEGINS IN NORTH AMERICA

Tobacco, already gaining popularity in Europe, was introduced as a commercial crop in Jamestown, Virginia. The New World plant's cultivation corresponded with the rise of tobacco culture in Europe, provided America with a fundamental economic underpinning by which plantation owners gained immense fortunes, and aided in the destruction and displacement of Native Americans.

LOCALE: Jamestown Colony (now in Virginia)

AGRICULTURAL ISSUES: European colonization; New crops and food products

KEY FIGURES

John Rolfe (1585-1622), English-born colonial official and first North American tobacco farmer

Sir Walter Raleigh (c. 1552-1618), English explorer who popularized tobacco in England

James I (1566-1625), king of England, r. 1603-1625, and king of Scotland as James VI, r. 1567-1625

SUMMARY OF EVENT

Tobacco was first introduced into Europe from North America before its establishment as a crop in Virginia. Native Americans consumed wild tobacco, which was plentiful in the Americas, rather than cultivating tobacco fields. The growing European desire for the New World plant, or “weede,” as it was initially referred to, literally saved the lives of the struggling British colonists and provided a means for their colonies to grow and prosper. While tobacco was widespread during the sixteenth and early seventeenth centuries, it was not until the second half of the seventeenth century that the price of tobacco fell drastically and tobacco became truly popular. The addictive desire for tobacco in Europe and eventually the rest of the world brought about enormous social, physical, and economic change.

It is difficult to imagine Europeans' initial response when they first viewed pipe smoking or snuff inhalation. They simply had no referential context whatsoever by which to understand the practice, so it is hardly any wonder such phrases as "drinking smoke" or "drinking fog" were invented for lack of better terms. Native Americans viewed tobacco as a medicine and used it also within social frameworks to bring people together in peace and camaraderie. With electrifying speed, Europeans, and soon after the rest of the world, borrowed American cultural and social practices surrounding the use of tobacco.

Tobacco, which gained an early reputation as a medicinal panacea, was introduced to France in 1556, Portugal in 1558, Spain in



The deep historical links between tobacco and Native Americans are expressed in this nineteenth century label for "Indian Girl" chewing tobacco. The picture depicts a young woman holding a sheaf of tobacco leaves above her head with one hand and white tobacco blossoms with her other hand. A tobacco plant can be seen at the base of the tree to the left. (Library of Congress)

1559, and finally to England in 1565. The explorer Christopher Columbus is actually credited with bringing tobacco to Europe at the end of the fifteenth century, but it did not become popular until the middle of the sixteenth century, when diplomats like France's Jean Nicot, for whom nicotine is named, began to use it as a curative. In France, where tobacco could only be purchased with a prescription, Queen Catherine de Médicis was so favorably impressed when it reportedly cured her headaches that she decreed that it be called *Herba Regina*, the "queen's herb."

After tobacco use moved beyond the medical arena, a culture of smoking, initially based on Native American social practices, sprung up in Europe. Pipes were ritually passed around from person to person in communal camaraderie by Native Americans to pledge an oath or ratify a treaty. This practice inspired the phrase "peace pipe." When Hernán Cortés landed in Mexico (1519), the native people offered him tobacco as "a pledge of peace and good will." Similarly, in early seventeenth century Europe, tobacco was "drunk" from a communal pipe that was handed from man to man around the table. In time, tobacco etiquette demanded that people of both genders cultivate the proper manner of smoking, which included a delicate hand.

Both genders and all ages smoked, including children, and, while smoking was the English nicotine delivery method of choice during the Stuart and Cromwellian eras, like many other imported French court manners, inhaling snuff gained in popularity after the Restoration of Charles II. Among aristocrats, it was common to have a different, enormously expensive snuff box for every day of the week.

In addition to the tobacco culture—smoking, snuff taking, and their accompanying mannerisms and accoutrements—tobacco also had a physical influence on seventeenth century bodies. Its ability to diminish the appetite led it to be used often in place of food. As a result, a reduction in the intake of meat, milk, and cheese accompanied Europeans' consumption of tobacco and allowed workers to work longer hours. Tobacco also played a role in major military conflicts, permitting soldiers to fight longer by increasing energy while keeping their bodies relaxed. In fact, seventeenth century European soldiers carried pipes in their caps, and tobacco constituted part of their daily rations.

The famous pipe smoker Sir Walter Raleigh is credited with popularizing tobacco in England during the reign of Queen Elizabeth I (r. 1558-1603). In 1587, Raleigh established a settlement on Roanoke Island in Virginia. After its failure, he attempted to colonize Guiana, rumored to be the mythical El Dorado, but instead of gold, he returned to England with tobacco.

The first successful commercial tobacco crop was cultivated in Virginia in 1612 by Englishman John Rolfe, secretary and recorder of the fledgling Jamestown Colony. Rolfe, who is also well known for marrying the Powhatan princess Pocahontas in 1614, obtained tobacco seeds in the Caribbean and planted them in Virginia in lieu of the more bitter native tobacco. This act literally saved the starving colonists. Two years later, he sent to England four hogsheads (252 dry gallons) of tobacco, weighing about 2,600 pounds (1,180 kilograms). The colony exploded with the growing and selling of tobacco. In the Chesapeake region of Virginia, tobacco was used as a medium of exchange by some Native Americans: It became a form of currency for the colonists as well, with everything bought and sold with tobacco.

Concern about his subjects' health had led the English king James I to issue *A Counterblaste to Tobacco* (1604), condemning tobacco as a "heathenish" poison. However, the tobacco market continued to expand, and, by 1617, Virginia had shipped around 10 tons (9,100 kilograms) of tobacco to England. The European demand for tobacco grew at a bewildering rate. In 1603, England had imported a total of only 25,000 pounds (11,300 kilograms) of the plant, but by 1640, tobacco had risen to first place among London's imports. In 1700, the nation imported almost 38 million pounds (17 million kilograms) and in 1771, over 100 million pounds (45 million kilograms).

SIGNIFICANCE

The introduction of tobacco crops as a commercial crop in seventeenth century North America had far-reaching social, physical, and economic significance. Its cultivation spurred the developing tobacco culture in Europe and throughout the world. Tobacco joined sugar and other plantation crops to form the heart of the colonial American economy, binding the colonies to developing world markets and providing an ever-greater impetus to import slaves to work

the plantations. Historians agree that tobacco made more fortunes than all the silver in North and South America.

Although mild when compared with early twenty-first century hard narcotics, nicotine's advance into Britain during the seventeenth and eighteenth centuries marked a major step in the development of global, imperialist capitalism. Tobacco, as an ever-increasing commodity, ensured the ongoing development of Virginia and provided an economic incentive for further expansion and settlement of the New World.

Furthermore, tobacco greatly influenced the displacement of Native Americans. Since it is a crop that is exhausting to the soil, virgin land must be cultivated continuously to keep up production. Thus, more and more land was needed to fulfil the rapidly expanding worldwide desire for tobacco. In order to meet the need for new territory, settlers took advantage of the Native Americans: By trading for mere pots and pans, the Indians lost control of their lands. The European and colonial craving for tobacco therefore played a major role in imperial acquisition and colonial expansion.

M. Casey Diana

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SEE ALSO: Beginning c. 1500: Coffee, Cacao, Tobacco, and Sugar Are Sold Worldwide; 17th century: England Undergoes an Agricultural Revolution; 17th century: Europe Endorses Colonial Economies Built on Slavery; Beginning c. 1619: Indentured Servitude Becomes Part of American Agriculture; 1625-1640: Barbados Becomes a Major Agricultural Colony; 1654: Portugal Retakes Brazil and Expands Its Economy; March 24, 1663-July 25, 1729: Tobacco and Sugar Farming Begin in the Carolinas.

■ BEGINNING C. 1615

COFFEE CULTURE FLOURISHES THROUGHOUT THE WORLD

Coffee, which became popular first among the Sufis during the early fifteenth century, reached the Middle East during the early seventeenth century and was soon exported to Europe and cultivated in Southeast Asia and Latin America. Within a few decades, coffee became a popular drink, as coffeeshouses—and the culture they spawned—spread from Arabic and North African countries to the European continent, England, and the New World.

LOCALE: Middle East and Europe

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Marketing and trade; New crops and food products; Tropical produce

KEY FIGURES

‘Abd al-Qāder Jazīrī (1505/1506-c. 1569), Arab chronicler, who wrote of the possible origins of coffee drinking

‘Alī ibn ‘Umar al-Shādhilī (fl. fifteenth century), Sufi leader in Yemen, reportedly the first to make coffee consumption popular among the Sufis

Murad IV (1612-1640), Ottoman sultan, r. 1623-1640, who attempted to prohibit coffee drinking

SUMMARY OF EVENT

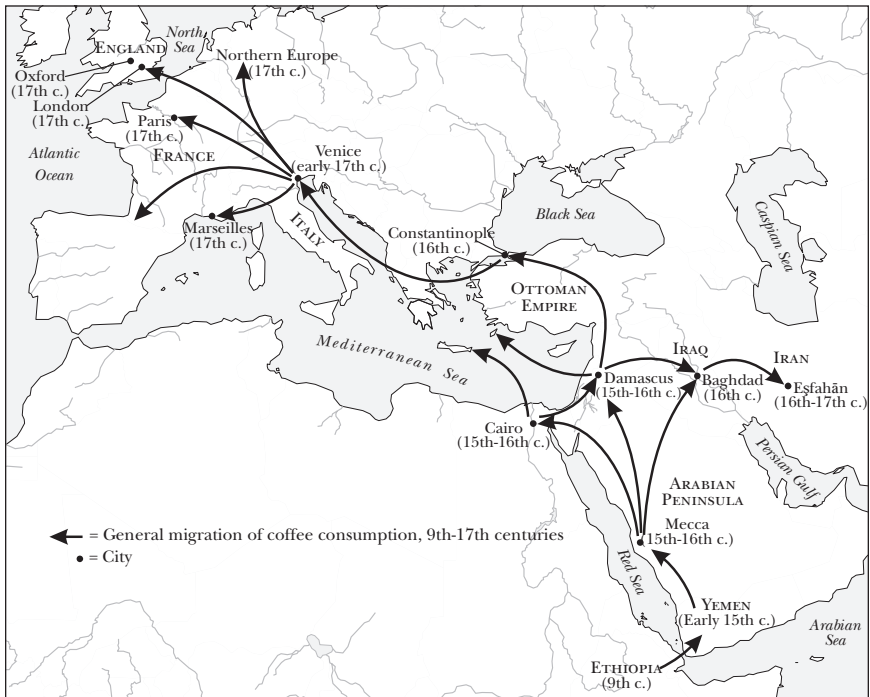
Coffee’s stimulating effects, according to one popular legend, were first realized by a ninth century Ethiopian shepherd who observed the excited behavior of the animals he was tending after they had eaten parts of a coffee plant. It is not surprising that this legend exists, given that the coffee plant is believed to be indigenous to Ethiopia in northeast Africa and possibly to Yemen on the southern Arabian peninsula. Coffee beans come from the flowering shrub *Coffea arabica* and its related species.

The tale of the Ethiopian shepherd, however, has been much disputed, and it remains legend. Historians agree, though, that coffee as some sort of consumable, most likely ground and eaten, originated

in Ethiopia, and there is general agreement that coffee's origins as a drink lie in fifteenth century Yemen. Why coffee became so popular in the Middle East and then in Europe remains a mystery.

Coffee, called the new drug by French cultural historian Fernand Braudel, first appeared in Europe by way of Venice around 1615. Along with tea, cocoa, and sugar, it was considered something exotic, something only the rich could afford and enjoy. It took another thirty years or so for coffee beans, and for specialty coffee cups and pots from the Muslim world, to reach Marseilles and Paris in France. It did not take long for coffee to become popular, and to change social life as it did in the Middle East possibly a century before. Usually, coffee was publicly consumed, making it a social drink, but it also was popular because it was supposed to be healthy. Ibn Kāshif al-Dīn Yazdī, a seventeenth century Persian pharmacologist and physician, recommended easing a hangover by taking an opium pill with coffee. Some, however, called coffee an “antiaphrodisiac” and a “eunuch’s

THE MIGRATION OF COFFEE CONSUMPTION



drink.” Still others, doctors namely, believed coffee “dried up the cerebrospinal fluid and the convolutions . . . the upshot being general exhaustion, paralysis, and impotence.”

Because history writing has traditionally meant recording monumental events, the story of seemingly trivial and mundane topics such as coffee and coffee drinking remains mostly undocumented. Cultural historians often must use as a starting point the time when something such as coffee consumption was first talked or written about. Historian Ralph Hattox, however, believes that in the case of coffee and coffeehouses, there is ample discussion in recorded history, though coffee history is not always detailed, and it is often made up of just “historical table scraps.”

During the sixteenth century, ‘Abd al-Qāder Jazīrī chronicled two legends about how coffee drinking started. In his posthumously published work *‘Umdat al-Ṣafwah fī ḥall al-qahwah* (c. 1588), Jazīrī writes that *qahwa* or *qahva* (coffee) was brought to the region from Ethiopia by Jamāl al-Dīn Abū ‘Abdallāh Moḥammad ibn Sa‘d Dabḥānī, a jurist during the early fifteenth century, who apparently witnessed the “use” of *qahwa* (which, if true, would mean coffee drinking could have originated in Africa). *Qahwa*, an Arabic term, and *qahva*, a Persian term, predate coffee use, and have been used to describe any drink made of plants that causes stimulation or intoxication, such as wine. Indeed, Europeans first called coffee from the Middle East the “wine of Islam,” especially its dark, rich, and thick Turkish blend.

Jazīrī also writes of a second origin story, one that is accepted by most historians. Jazīrī reports that Sufi leader ‘Alī ibn ‘Umar al-Shādhilī was the first to make coffee consumption popular among the Sufis in Yemen, giving coffee its earliest reputation as a stimulating drink. The Sufis embraced coffee because it allowed them to stay awake through the evening and night to devote their unbridled time and energy in prayers to God. Al-Shādhilī became, according to modern historian ‘Alī Āl-e Dāwūd, “a kind of patron saint of coffee growers and coffeehouse owners.”

It is most likely that the spread of coffee culture into the rest of the Islamic world—and then into Europe and the New World—originated with the Sufi orders of Yemen, and inherent in that coffee culture was not just the drinking of coffee but the drinking of coffee with others: In its earliest stages, coffee drinking was a social event.

Coffee drinking soon moved out of the strictly religious, pious realm and into the realm of pleasure, becoming a part of public gatherings. These public gatherings became fledgling “coffeehouses,” and were modeled on existing wine taverns.

From Yemen, coffee consumption spread rapidly to other areas of the Middle East, including Mecca and Cairo, and later to Baghdad, Damascus, Constantinople, and other major cities. The Ottomans, whose territory stretched to southern Yemen during the early sixteenth century, exported coffee beans throughout their vast empire. The Ottoman capital, Constantinople, opened the world’s first-known coffeehouse around 1554-1555. According to historian Heinrich Eduard Jacob, the early Turkish coffeehouses were called *mekteb-i-irfan* (schools of the cultured) and coffee was called “the milk of chess-players and of thinkers.” So popular was coffee drinking that the Ottoman court established a coffee “department” called a *qahva-kāna*, the same name for “coffeehouse.” The court’s *qahva-kāna* was supervised by a *qahvači-bāšī*.

Muslim pilgrims, starting during the early seventeenth century, would smuggle the beans of the highly regulated—and much desired—crop to other parts of the Middle East, and it made its way to ports busy with European traders and merchants. The trade in coffee began as the British East India Company and the Dutch East India Company exported the coffee bean from Middle Eastern and North African ports and traded it within the region; it did not take long to reach Europe. The Dutch were the first to bring the beans to areas such as Ceylon (Sri Lanka), Indonesia, and, during the early eighteenth century, South America, for cultivation.

Opposition to *qahwa*’s intoxicating effect came swiftly in the form of civil unrest, and official condemnation came in the form of fatwas (legal-moral opinion). The coffeehouses persisted, though, despite their reputation as nothing more than taverns. According to Hattox, the coffeehouses were different from taverns in one fundamental way: “the coffeehouse was a tavern without wine, and as such . . . it was not a cause of shame to be caught in one.” Fearing no public condemnation or shame, people could patronize the coffeehouses, and soon they became more and more popular. Ottoman sultan Murad IV tried to prohibit coffeehouses, along with tobacco and wine shops and the use of opium, but the prohibitions did not last.

COFFEE AND HEALTH

In The Manner of Making of Coffee, Tea, and Chocolate (1671), physician Philippe Sylvestre Dufour outlines what he believes are the health benefits of coffee. Readers likely will be overjoyed to hear that coffee “drives away wind” and cures other ills—even (contrary to modern medical science) stomachaches.

It dries up all cold and damp humours, drives away wind, strengthens the liver, relieves dropsies by its purifying quality; sovereign equally for scabies and impurity of the blood, it revives the heart and its vital beat, relieves those who have stomach ache and have lost their appetite; it is equally good for those who have a cold in the head, streaming or heavy. . . . The vapour which rises from it [helps] watering eyes and noises in the ears, sovereign remedy also for short breath, colds which attack the lungs, pains in the spleen, worms; extraordinary relief after over-eating or over-drinking. Nothing better for those who eat a lot of fruit.

Source: Quoted in Civilization and Capitalism: Fifteenth to Eighteenth Century. Vol. 1 in The Structures of Everyday Life: The Limits of the Possible, by Fernand Braudel (New York: Harper & Row, 1981): p. 257.

Europeans began writing extensively about coffee and Middle East coffee culture in the seventeenth century. English poet George Sandys (1577-1644) in 1610 thought coffee “black as soote, and tasting not much unlike it,” adding, “it helpeth, as they say digestion, and procureth alacrity.” Pope Clement VIII was asked to outlaw coffee, but after trying it himself, he reportedly said, “Why, this Satan’s drink is so delicious that it would be a pity to let the infidels have exclusive use of it. We shall fool Satan by baptizing it and making it a truly Christian beverage.” Pietro della Valle wrote in 1615 that coffee “prevents those who consume it from feeling drowsy. For that reason, students who wish to read into the late hours are fond of it.” Thomas Herbert visited Persia during the 1620’s and wrote, “There is nothing of which the Persians are fonder than ‘coho’ or ‘cophā,’ which the Turks call ‘caphe.’ This beverage is so black that one might suppose it to have come from the River Styx. . . . Drunk very hot, it is said to be wholesome, dispelling melancholy, drying tears, allaying anger, and producing cheerfulness.”

Other seventeenth century works that mention coffee include



*Arabs relaxing in an early
twentieth century Middle
Eastern coffee house.*
(Library of Congress)

Francis Bacon's *Historia vitae et mortis* (1637; *The Historie of Life and Death*, 1638) and *Sylva sylvarum* (1627; *Sylva Sylvarum: Or, A Natural History*, 1664), Robert Burton's *Anatomy of Melancholy* (1632), the botanical description in John Parkinson's *Theatricum Botanicum: The Theater of Plants* (1640), and physician Philippe Sylvestre Dufour's *De l'usage du café, du thé et du chocolat: Dialogue entre un médecin, un Indien, et un bourgeois* (1671; *The Manner of Making of Coffee, Tea, and Chocolate: As It is Used in Most Parts of Europe, Asia, Africa, and America, With Their Vertues*, 1685). Persian physician Yazdī dedicated to Shah 'Abbās II (r. 1642-1666) a treatise on coffee and tea called *Resāla-ye čūb-e čīnī wa qahva wa čāy* in 1664.

Coffeehouses and coffee drinking profoundly affected society, first in the Middle East and then in Europe. In Persia, the coffeehouses were called *qahva-kāna*, or coffee rooms, according to contemporary chronicler Adam Olearius, a German scholar and embassy secretary, in his work *The Voyages and Travels of the Ambassadors* (1662), regarding his travels through Persia in the seventeenth century. The larger, more elaborate establishments took shape also as smaller shops and as market stalls and street carts. They often were "grand" or "luxurious" places, located in gardenlike or park settings, with both indoor and outdoor seating. Most significant in the devel-

opment of a specifically coffee culture was that it afforded a place to see and be seen, to hear music, poetry, and narration (storytelling, speeches, drama), to play games, and to discuss politics and other controversial subjects. Talking politics, and not coffee drinking itself, turned coffeehouses into salons of a sort. Coffeehouses also were places for conducting business, for drug use, for sitting and staring, for arranging sex between males, and for idle talk, rumor, and innuendo, especially regarding women. Women were not permitted in coffeehouses of the time, except, on some occasions, as performers. To some the establishments were reputable, innocent places, but to others, especially local governments, religious leaders, and the deeply pious, they were disreputable, seditious, and subversive. The coffeehouses would hold the attention of authorities.

Coffee changed the makeup of everyday, public life. Coffee culture came to be accepted more and more, and the gatherings soon included men from all walks of life. Also, coffee roasting and brewing introduced new smells to a city, town, or village, and, “where formerly the lights at night burned mostly from the mosque, and there usually only at times of festival, the lights burned far into the night in the coffeehouses,” mainly because they were “packed with people.” Coffee as it was brewed and served in the Middle East, especially in Turkey, was too strong and bitter for many in the West. European consumers of the drink wanted something more “tasty” and palatable, so they often added milk and sugar. Šafavid shah ‘Abbās the Great (r. 1587-1629) responded to the popularity of coffeehouses in Persia, and to their reputation for the irreligious and immoral, by placing a mullah in a well-known coffeehouse in Ešfahān. The mullah would give talks about religion, law, literature, and history but would see to it that patrons went about their daily lives, too, discouraging people from “hanging out.” The Persian government, in effect, ensured that patrons remained “civil.” Mystics and other religious figures soon followed the mullahs, and the places often became sanctuaries of a sort for those in need of guidance, spiritual or otherwise.

The idea of the coffeehouse in Europe was modeled on the inns and monasteries that catered, since the twelfth century, to Christian travelers and pilgrims in need of a place to eat and rest. European coffeehouses also were modeled on cook shops, an early form of the restaurant, which thrived in Europe beginning in the fifteenth cen-

ture as urban populations expanded. Not until the second half of the seventeenth century did coffee drinking become popularized, as it moved into ordinary cafes. In these cafes, one could find men of all classes and income levels, and women were welcomed in female-only establishments.

Exactly when the first coffeehouse in Europe opened is not clear. Some say 1645 in Venice (when it was called a *caffè*), others say around 1650 in Oxford, England. Still others place the first Venice coffeehouse as late as 1685. Another opened at St. Michael's Alley, Cornhill, London, in 1652. An extant handbill, or flyer, from this London shop reads, "The Vertue of the COFFEE Drink." In Canada, the Hudson's Bay Company held its first public sale of fur at Garraway's Coffee House in 1672. Coffee was sold from carts in Venice by the 1650's as well. Another early coffeehouse on the European continent most likely opened in 1671 in Marseilles, with another opening in Paris the next year. By about 1670, there were possibly as many as five hundred coffeehouses in England, albeit in all forms, from carts to stalls to shops. Also by the end of the century, coffee made its way to Germany and to the Netherlands.

As in the Middle East, with coffee drinking in Europe came great controversy. Citing concerns over its health consequences as well as its general effect on society and culture, pamphlets and broadsides such as *A Coffee Scuffle* (1662) and *The Character of a Coffee House . . . by an Eye and Ear Witness* (1665) raged against the "seminaries of sedition." *The Women's Petition Against Coffee* (1674) argued, "We find it of late a very sensible *Decay* of that true *Old English Vigour*. . ." This "decay" came from "the Excessive use of that Newfangled, Abominable, Heathenish Liquor called *Coffee*, which . . . has so *Eunucht* our Husbands, and *Crippled* our more kind *gallants*. . . They come from it with nothing *moist* but their snotty Noses, nothing *stiffe* but their Joints, nor *standing* but their Ears." England's king Charles II even intervened, or tried to, when he issued an order to suppress the coffeehouses in 1675. The order was rescinded, and the places kept serving coffee.

SIGNIFICANCE

Coffee culture flourished and gained widespread popularity at a time that saw the expansion and dissemination of knowledge as well as an

influx of consumables from around the globe. Coffee became a major commodity of exchange in world trade and commerce.

Not knowing the story of *qahwa*'s origins would make it easy to discount its significance to cultural and, indeed, world history. After all, it is just a drink. However, coffee's introduction into the Middle East and Europe forever transformed the global marketplace, affecting economics, politics, literature, the arts, urban life, and the way information was distributed; the coffeehouse became a library of sorts for "newsbooks," newspapers, and political papers. Coffee culture brought to everyday life new tastes and smells and a new culinary experience, and people gathered for reasons other than religious, a novelty at the time.

By the end of the seventeenth century, coffee drinking was more common than ever, and it reached well beyond the coffeehouse into cafes, restaurants, and homes. It also jumped across the Atlantic Ocean to the Americas, where it was first sold in the colonies of North America around 1670, possibly in Boston. It became not only a favorite pastime but also a major crop, especially in Latin America.

In the first years of the twenty-first century, coffee was second only to petroleum in world trade, and coffee remains one of the most-consumed drinks. The business of coffee, from growing, trading, manufacturing, and selling, employs millions of people worldwide.

Desiree Dreeuw

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Journal Company, 1935. This classic work on the economic and cultural history of coffee includes a “coffee thesaurus” called “Encomiums and Descriptive Phrases Applied to the Plant, the Berry, and the Beverage.”

SEE ALSO: Beginning c. 1500: Coffee, Cacao, Tobacco, and Sugar Are Sold Worldwide; 17th century: Europe Endorses Colonial Economies Built on Slavery; 1656: Popularity of Chocolate Increases Cacao Planting; 1874: Barbed Wire Fencing Transforms American Ranching.

■ BEGINNING C. 1619

INDENTURED SERVITUDE BECOMES PART OF AMERICAN AGRICULTURE

To meet the need for unskilled labor in the American colonies, European colonists imported poor people who were willing to agree to a limited period of servitude in return for passage to the New World and a parcel of land once their servitude ended. This practice began the reliance upon unfree labor that would shape the history of American agriculture well into the nineteenth century.

LOCALE: English North American colonies, including the West Indies

AGRICULTURAL ISSUES: Labor; Migration; Population growth; Slavery

KEY FIGURES

Sir George Peckham (d. 1608), early English advocate of exporting the unemployed to the New World

Sir Edwin Sandys (1561-1629), treasurer of the London Company

SUMMARY OF EVENT

The American colonies were started by early capitalistic enterprises, such as the London Company (also known as the Virginia Company of London), which had been assigned the southern portion of the American coastline as a trading post by King James I. Between 1607 and 1618, several attempts were made to establish a settlement on the James River, but their original concept failed, and by 1618 the company had been converted into a system for encouraging the settlement of Englishmen in America.

The concept of “indentured servitude” was based on the common practice in England of “service in husbandry,” in which individuals bound themselves or their children to work on the farms of the larger landowners for a period of a year or more. Adapting this concept to the peopling of the New World was first suggested by Sir George Peckham and picked up by Sir Edwin Sandys, treasurer of the London Company, which established the first colony in Virginia in 1607. In the case of indentured servants in America, the idea was for impoverished

Englishmen to take passage on a ship to the colonies and to repay those who financed the sea voyage with their labor for a fixed period of time. After they had worked off their debt, indentured servants became freemen with the ability to own land of their own, an ability that would have been beyond them back in their home country.

The opening up of land in America occurred at a time in Europe when the population had been expanding more rapidly than wages, and there was in consequence a significant surplus of agricultural workers. In Elizabethan England, these workers were classified as "rogues and vagabonds," and were regarded as a superfluous population. Many wandered into the rapidly growing cities, such as London and Bristol, and the authorities in those cities were anxious to get rid of them. To accomplish this goal, laws were passed and strictly enforced mandating heavy punishments for relatively minor crimes, and the large number of convictions that resulted provided an instant, exportable pool of labor for the colonies. Furthermore, the religious conflicts of the period resulted in many military prisoners, and "transportation" was the easiest way to dispose of them. Likewise, the many orphans roaming city streets could be rounded up and sent to America.

In the earliest years, the need for labor was greatest in the southern colonies on the American continent and in the West Indies. The enormous profitability of sugar led to many indentured servants being sent to the sugar plantations in such colonies as Barbados, but the tropical climate killed many, and by the middle of the century, indentured servants were used in the sugar colonies chiefly as supervisors of the African slaves who began arriving in large numbers at that time. On the mainland, the need for indentured servants was greatest in the tobacco colonies, Virginia and Maryland, for next to sugar, tobacco was the most profitable product of America.

Though some indentured servants went to the Carolinas, the combination of a semitropical climate and the character of the chief agricultural product, rice, soon led to their displacement by African slaves. Although slaves came during the seventeenth century to provide much of the field labor in the tobacco fields, there continued to be a demand for white indentured servants to fill other roles in the Carolina colonies. In the middle colonies, where the chief crop was wheat, the need was not so great, and the indentured servants who

worked there continued to be used for agricultural labor. In New England, the earliest immigrants had large families and used them for a workforce, so few indentured servants were needed.

Over the course of the seventeenth century, the legal requirements of indentured servitude came to be codified, chiefly by the colonial legislatures. As early as 1619, the Virginia General Assembly tried to encourage indentured servants to immigrate by promising that, following their period of service (four years unless the servant was very young), servants would qualify for a land grant, normally fifty acres (twenty hectares). Many who qualified never actually acquired the land, however, finding it easier to sell their “headright” (as the land grant was called) to those who already had sufficient capital to exploit the land. In the West Indies, because there was no surplus of land to grant, cash incentives were sometimes offered.

One of the biggest problems with which colonial legislatures had to deal was the relatively high risk that indentured servants would try to run away after reaching America, thus depriving the persons who paid their transatlantic passages of returns on their investments. Heavy penalties, including increased time of servitude, were levied on runaways, who could be legally pursued until they were caught and returned to their “owners.” Because convicts were particularly prone to running away, colonial legislatures attempted to stop the transporting of convicts, but the English government overturned such laws: The English were more interested in getting rid of their downtrodden masses than they were in aiding their colonial subjects.

During the late seventeenth century and early eighteenth centuries, to aid in keeping track of bonded servants, bureaucratic offices were created where documentation of indenture was to be formally registered. This bureaucratic system was not uniform throughout England, but Bristol, for example, had such a registration service for a number of years. In the eighteenth century, registration became virtually automatic, especially in the case of those who came as families, known as “redemptioners.”

In the seventeenth century, especially during the early years, the majority of the indentured servants were male unskilled laborers who were put to work performing agricultural labor. Some women came as well, and they were normally used as household servants. Not a few became the wives of landowners, and their children sometimes rose

in social standing. By the late seventeenth century, however, the greatest demand was for men with recognizable skills, including blacksmiths, masons, carpenters, and wheelwrights, as well as literate individuals who could manage the accounts of plantations. Unskilled labor had begun to be provided predominantly by slaves.

SIGNIFICANCE

Although the system of indentured servitude undoubtedly made it possible for many individuals without capital to emigrate to the new colonies in the New World, it ultimately served to perpetuate the social system that prevailed at the time, with a small elite at the top and large numbers at the bottom of the social scale. Some indentured servants, even some black indentured servants, did indeed become landowners, who ironically employed indentured and enslaved laborers themselves on their new lands. The vast majority, however, merely changed the venue in which they lived hand-to-mouth and ended their lives with substantially the same means they had had when they emigrated from England.

More important than the maintenance of traditional European social hierarchies, indentured servitude gave legitimacy to a system in which individuals, brought to the New World at the expense of others, constituted a capital asset that could be bought and sold. It laid the foundations for the practice of African slavery in America.

Nancy M. Gordon

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■ 1625-1640

BARBADOS BECOMES A MAJOR AGRICULTURAL COLONY

Captain John Powell claimed Barbados for England in 1625. In 1627, Sir William Courteen established England's second Caribbean colony on the island. Barbados's settlers founded a plantation economy based on tobacco and cotton, but during the 1630's, sugar supplanted tobacco as the primary cash crop.

LOCALE: Barbados, Caribbean Sea

AGRICULTURAL ISSUES: Drought; European colonization; Famine and hunger; Slavery; Tropical produce

KEY FIGURES

John Powell (fl. 1624-1625), English captain and governor of Barbados, 1629

Henry Powell (fl. 1627-1628), English captain and governor of Barbados, 1627-1628

Sir William Courteen (1572-1636), English merchant and lord proprietor of Barbados, 1625-1627

Henry Hawley (fl. 1630's), governor of Barbados, 1630-1633, 1634-1638, 1639

Charles Wolferston (fl. 1628-1629), governor of Barbados, 1628-1629

Philip Herbert (d. 1669), earl of Pembroke and supporter of Courteen

James Hay (1612-1660), earl of Carlisle and lord proprietor of Barbados, 1627-1652

SUMMARY OF EVENT

On May 14, 1625, Captain John Powell stopped at Barbados on his voyage from Brazil to England. Finding the island uninhabited, Powell claimed it for England and King James I. He named the landing site Jamestown (now Holetown). On Powell's return trip to England, he stopped at Saint Christopher (Saint Kitt's), settled by the British in 1624, to report his claim to Sir William Courteen, a wealthy merchant who controlled an important English trading company.

Courteen, his brother Peter Courteen, John Mounsay, and Captains John Powell and Henry Powell launched the first expedition to occupy Barbados.

On February 17, 1627, Captain Henry Powell arrived with eighty settlers and ten African slaves at Jamestown. The settlers immediately felled trees and built log houses along the seashore. They found tropical fruits in abundance and wild hogs for meat. While the settlers cleared land, Powell went to Essequibo, Guiana, to obtain seeds and foodstuffs from his old friend Adrian Groenewegen, the governor of the Dutch colony there. With Groenewegen's permission, thirty-two Arawak Indians returned with Powell to Barbados, to provide seeds and expertise in cultivation. The Arawaks were supposed to remain free men and receive land for themselves but eventually were reduced to slavery.

In May of 1627, Captain John Powell arrived with a cargo of supplies and ninety men and women—mostly indentured servants. By mid-1627, the Courteen colony had cleared land seven miles (eleven kilometers) inland, built one hundred houses, and started five plantations. The Arawaks helped plant food crops of fruits, cassava, corn, and potatoes, along with cash crops of tobacco, cotton, ginger, and indigo. Barbados's population increased rapidly, and soon there were a dozen thriving plantations, along with numerous small farms. European indentured servants, African slaves, and Caribbean Indians made up the labor force.

English politics interfered with Barbados's development, however. James Hay, earl of Carlisle, petitioned King Charles I for title to Barbados. His creditors, primarily a syndicate of London merchants headed by Marmaduke Royden, supported his petition in order to use Carlisle to gain a foothold in the lucrative island trade. In July, 1627, Charles I awarded Carlisle a patent to the "Caribbee" Islands, including Barbados, and named him lord proprietor of the island. To clear his debts, Carlisle leased 10,000 acres (4,045 hectares) to Royden's syndicate.

When Sir William Courteen discovered this intrigue, he sought help from Philip Herbert, earl of Pembroke, who claimed Barbados under a patent from King James I. On February 25, 1628, Pembroke persuaded King Charles to grant him the islands of Trinidad, Tobago, Barbados, and Fonseca in trust for Courteen. In response,



*West Indian woman
pounding cassava.*
(Library of Congress)

Carlisle obtained another grant from Charles confirming that Barbados was included in his Caribbee Islands patent. The lord keeper Coventry ruled that Carlisle's patent was valid, so a royal edict went to the governor of Barbados in May, 1629, declaring the earl of Carlisle's title to the island to be in full force. Thus, Carlisle obtained sovereign rights over Barbados. He received all subsidies, customs, and taxes for ten years and could select the estates he desired for his private domain. The planters, who paid the taxes and subsidies, were caught up in the war of intrigue and litigation between Carlisle and Courteen.

On March 19, 1628, Lord Proprietor Carlisle commissioned Captain Charles Wolferston as governor and commander-in-chief of Barbados for three years. Wolferston arrived in Barbados in June, 1628,

with sixty-four men, took over as governor, and claimed jurisdiction over Courteen's planters. When Governor John Powell opposed this action, Wolferston put him in prison. In October, 1628, Carlisle sent two merchants named Havercamp and Mole with twenty men to start a new plantation. They persuaded some of the Courteen planters to accept Carlisle's sovereignty, established Carlisle's private plantation, and returned to England.

On February 26, 1629, Henry Powell arrived with a cargo of supplies and about one hundred men and women. Angered at his brother's imprisonment, Powell seized Wolferston and William Deane, a planter who had defected to Carlisle, then released John Powell from prison and reinstated him as governor. All of the Royden syndicate's possessions were confiscated, including servants and tobacco. Henry Powell secured a shipload of tobacco from the Courteen planters, along with their pledges of allegiance, and sailed for England, with Wolferston and Deane aboard as prisoners.

Carlisle retaliated in August of 1629 by sending Henry Hawley to Barbados as governor. Hawley tricked John Powell and loyal Courteen planters aboard his ship, chained them to the mainmast, and departed for the Leeward Islands, leaving Robert Wheatley in charge as deputy governor. Enraged, Courteen planters mounted an armed attack on Wheatley, but Wheatley won the battle and confiscated all plantations that fell within the Carlisle acreage. Hawley returned in triumph to resume his role as governor in 1630, but the conflict, compounded by severe drought in 1629 and Carlisle's failure to send supplies from Europe, wrought such devastation in Barbados that the years 1630-1631 became known as the Starving Time.

Barbados regained the lost ground of the Starving Time when it transitioned to sugar production during the 1630's. Dutchmen from Guiana brought sugarcane for planting and technology for producing sugar, and sugar soon supplanted tobacco as Barbados's chief export. Like tobacco and cotton plantations, sugar plantations were dependent upon slaves and indentured servants. Dutch merchants supplied slaves from West Africa, and poor English whites came to Barbados as indentured servants. Some servants were kidnap victims, and on occasion, convicted criminals were shipped to Barbados as laborers. Descendants of the white slaves and indentured laborers were known as Red Legs. Visitors to Barbados during the early 1630's re-

ported the poor conditions in which slaves and servants lived, as well as widespread drunkenness and immorality among the planters. These evils were attributed to the lack of sufficient clergy and a failure to maintain a strong religious influence on standards of behavior.

In December, 1634, the lords commissioner for the plantations ordered that no more “subsidy men” (that is, men of substance who might pay taxes) be allowed to emigrate. In 1635, a total of 707 men and thirty-six women left London for Barbados. Among these were very few planters but numerous tradesmen, craftspeople, and servants. By 1639, the population in Barbados had reached ten thousand, and the planters had retrieved their political power. The island’s first parliament was held in 1639, making Barbados’s parliament the third oldest legislative body in the Commonwealth, after the British House of Commons and Bermuda House of Assembly. Barbados held so closely to English government, laws, and traditions that it became known as Little England.

SIGNIFICANCE

Barbados was important to the British for its strategic location, lying to windward (east) of the island chain of the Lesser Antilles and not so vulnerable to attack by the Spanish. The colony proved increasingly profitable as a sugar producer and trading post for the British in the Caribbean. In 1651, Barbados was besieged by Oliver Cromwell’s military forces and forced to sign Articles of Capitulation in 1652. The Parliament, however, turned the articles into a Charter for Barbados and used the charter to win a measure of independence from the English monarchy when it was restored in 1660. From 1640 to 1700, despite periodic slave unrest and destructive hurricanes, Barbados maintained a successful sugar plantation society and economy, and moved ever further toward home rule.

Marguerite R. Plummer

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■ 1630's-1694

BRAZIL'S PLANTATION SLAVES BUILD INDEPENDENT STATE AT PALMARES

Through much of the seventeenth century, African slaves who fled from the sugar plantations along the coast of northeast Brazil journeyed to Palmares, a multiracial and multiethnic community built by former slaves. Although Dutch and Portuguese slaveholders mounted numerous well-armed attacks, the inhabitants of Palmares bravely resisted for nearly a century.

LOCALE: Territory on the border of Alagoas and Pernambuco in northeast Brazil

AGRICULTURAL ISSUES: European colonization; Slavery; Tropical produce

KEY FIGURES

Zumbi (1655-1695), black leader of Palmares

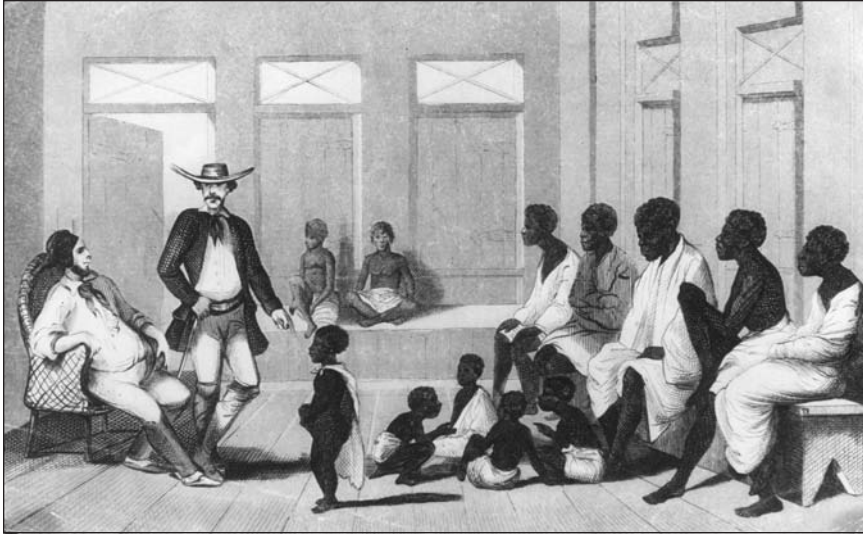
Ganga Zumba (d. 1680), black leader of Palmares

Domingos Jorge Velho (1614?-1703), Brazilian-Portuguese explorer, adventurer, and slave catcher

SUMMARY OF EVENT

In the second half of the sixteenth century, Portuguese settlers in Brazil began to plant and process sugarcane, and by the early seventeenth century, northeast Brazil supplied most of Europe's sugar. In order to staff the plantations, the Portuguese expanded the slave trade from Africa. As sugar production increased, so did the numbers of Africans brought in bondage to Brazil.

Life on the sugarcane plantations was brutal for slaves, who often worked sixteen-hour days, toiling in the fields. Working in the boiling rooms where the juice of the cane was transformed into sugar was not much better: The heat generated by the copper cauldrons in which the cane syrup was boiled was so intense the experience was compared to life in hell. Not surprisingly, slaves fled the plantations. Finding it impossible to make their way back to Africa, they established communities in the interior of Brazil, where they re-created, as much



Late eighteenth century drawing of a Brazilian slave trader inspecting newly arrived Africans. (Hulton Archive/Getty Images)

as possible, the life they had known before being brought to Brazil and enslaved. Slaves on Brazilian sugarcane plantations came from many different regions in West Africa. Thus, runaway communities saw a variety of blended African customs and traditions. Because African women were always in short “supply” (Brazilian planters preferred to purchase men for the hard labor on sugar plantations), runaway slaves often formed families with indigenous and mixed-race women. Thus, these communities became multiracial and multiethnic, combining a variety of African, indigenous, and European ways.

Africans clearly despised life on sugar plantations, but Europeans coveted the wealth generated by the Portuguese. In 1624, a Dutch naval expedition attacked the Brazilian capital city of Salvador, hoping to take over control of both the production and the supply of sugar. Repulsed by the Portuguese settlers in 1625, the Dutch struck again in 1630, this time farther north, successfully taking the cities of Recife and Olinda in the captaincy of Pernambuco. For twenty-four years, the Dutch remained in possession of this rich sugar area in northeast Brazil. The Portuguese did what they could to expel them.

African slaves took full advantage of the fighting between the Portuguese and the Dutch in Pernambuco. Between 1630 and 1654, the

largest runaway slave community in Brazilian history expanded to become a thriving alternative to colonial society. By the 1650's, Palmares included eleven villages, the largest of which was home to eight thousand people living in fifteen hundred households. Palmares at that time had a total population of between twenty thousand and thirty thousand.

By all accounts, Palmares was much more than a hideout for runaway slaves. It was a thriving community organized in a fair and representative manner (the chief was elected by a council of warriors). Because those who lived in Palmares were not interested in supplying the European market, they used their rich soil to plant food such as manioc, maize, and many varieties of fruits and vegetables. This bountiful production nourished healthy inhabitants, while Palmares's leaders trained security forces to protect the community from outside attack. Their crops produced such an abundance that *palmarinos* engaged in trade with the plantations, supplying food for masters and slaves in return for firearms and other goods they could not produce. When unsuccessful at getting supplies through trade, *palmarinos* raided plantations and took what they needed. Over time, Palmares became a beacon for the oppressed plantation slaves, an alternative to their life in captivity. As such, the village threatened the control of slave masters and the authority of the Portuguese and Dutch colonial states.

The Dutch sent several expeditions to destroy Palmares, yet none succeeded, and the expulsion of the Dutch in 1654 encouraged the Portuguese to turn military attention against Palmares as well. In a 1655 raid, the Portuguese captured some of the children born in Palmares, including an infant who would later become the greatest leader of Palmares, the warrior Zumbi. This child was taken in and raised by a priest, who gave him the Christian name Francisco. He was taught to read and write both in Portuguese and in Latin. Apparently, Francisco was treated well by his foster father, for many years later, once back in Palmares, Zumbi sent the priest gifts on several occasions. Despite a more pleasant life than that of most slaves, once he became a teenager, he decided to cast his lot with the *palmarinos*. In 1670, he returned to Palmares and took the name Zumbi. He proved to be an exceptional warrior, rising quickly to become one of Palmares's most accomplished generals.

By the time of Zumbi's return, Palmares had become an armed encampment. Portuguese attempts to destroy the community had intensified; authorities were even encouraging *bandeirantes*, mixed-race individuals who hunted the indigenous for enslavement in the south of Brazil, to come north with their men and help eliminate the "black republic."

In 1678, following a costly Portuguese raid, the elected leader of Palmares, Ganga Zumba, negotiated a peace settlement with Portuguese authorities. In return for guarantees of land for himself and for his followers who had never been slaves, he agreed that slaves taken from plantations would be returned to their owners. Many in Palmares thought he was foolish to trust the white men, and some believed that turning over any black man to a slave master was betrayal. Zumbi, who helped to organize resistance to Ganga Zumba, eventually became the leader of the faction that chose to continue to defend Palmares.

Although Ganga Zumba was given land, he and his followers soon discovered they were not free from raids by settlers searching for new slaves. Blacks living in the community continued to be viewed as potential slaves. Not long after leaving Palmares, Ganga Zumba was poisoned (possibly on Zumbi's orders), and he died. It became clear to *palmarinos* that any negotiation with the whites would lead only to disaster. Peace was no longer an option. As the state mounted a number of attacks on Palmares, the former slaves dug in and resisted. They repulsed at least fourteen well-organized military attacks as they struggled to maintain their vision of an alternative way of life for black men and women in Brazil.

During the 1680's, a notorious *bandeirante*, Domingos Jorge Velho, was invited to bring his men and reinforce local government troops in a concerted attack on Palmares. When he and his men arrived in 1693, they mounted a serious challenge to Palmares. After a number of unsuccessful attempts, the five thousand troops took Macaco, the capital of Palmares. Zumbi escaped and began to regroup. One of the captured *palmarinos* under torture agreed, however, to take the troops to Zumbi. Thus, betrayed by a friend, he was captured and killed on November 20, 1695. Permanently destroyed was his free community where Africans, indigenous, and mulattoes (mixed race) worked for their own well-being.

SIGNIFICANCE

Palmares has become the ultimate symbol of black resistance in Brazil. Those who lived in Palmares created a viable alternative to a colonial system that abused Africans and Amerindians in order to supply agricultural commodities to the European market. At Palmares, African slaves organized their own government and forged a more equitable economic system than the one established by Europeans. In the face of numerous attacks, the inhabitants of Palmares organized armies and held back the raids of Europeans for almost a century. Their last leader, the great Zumbi, refused to believe the false promises of the Europeans and died rather than betray his people. In the twenty-first century, the slaves who escaped to Palmares continue to provide Brazilians with proud examples of the capacity of Africans and their descendants to engage in a noble struggle against racism and economic oppression.

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1630's-1694

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SEE ALSO: Beginning c. 1500: Coffee, Cacao, Tobacco, and Sugar Are Sold Worldwide; 17th century: Europe Endorses Colonial Economies Built on Slavery; 1625-1640: Barbados Becomes a Major Agricultural Colony; 1654: Portugal Retakes Brazil and Expands Its Economy.

■ JANUARY 29, 1649

RUSSIAN SERFDOM IS CODIFIED

The codification of serfdom in Russia completed a process begun by the Muscovite state in the first half of the fifteenth century and marked the legalization of an institution that would remain a fundamental feature of Russia's society and economy until the second half of the nineteenth century.

LOCALE: Muscovy (now Russia)

AGRICULTURAL ISSUES: Agrarian reform; Feudalistic systems; Government policy and regulation; Labor

KEY FIGURES

Ivan the Terrible (1530-1584), czar of Muscovy, r. 1547-1584

Fyodor I (1557-1598), czar of Muscovy, r. 1584-1598

Vasily Shuysky (1552-1612), czar of Muscovy, r. 1606-1610

Michael Romanov (1596-1645), czar of Muscovy, r. 1613-1645

Alexis (1629-1676), grand prince of Muscovy, r. 1645-1676

SUMMARY OF EVENT

On January 29, 1649, Muscovy's *zemskii sobor* (assembly of the land), a consultative assembly consisting of representatives from the Muscovite elites, ratified the Ulozhenie, Russia's fundamental law code that lasted until the 1830's. Drawn up by a five-man commission, headed by Prince Nikita Odoevsky, and consisting of twenty-five chapters, the Ulozhenie, chapter 11 specifically, effectively turned peasants residing on both seigniorial and nonseigniorial lands into serfs by abolishing a previously established statute of limitations on landlords. The statute had restricted the amount of time a landlord had to recover fugitive peasants, gave the state responsibility for recovering fugitive peasants, and threatened dire consequences for anyone found harboring fugitive peasants. The term "serf" means a peasant possessed by a noble, who is tied to land for sustenance and subject to the landlord's will.

The codification of serfdom found during the 1649 Ulozhenie represented the culmination of a relatively lengthy process by which the Muscovite state limited the movements of peasants in Russia. This

RUSSIA'S CODE OF 1649

The Ulozhenie, Russia's law code, was created in 1649 and became the most comprehensive in Russian history, lasting nearly two centuries. The excerpt here is from "Legal Procedure Concerning the Peasants," a section consisting of thirty-four articles that outlines the rights and obligations of landowners and the legal and property status of peasants, or serfs.

1. All peasants who have fled from lands belonging to the Tsar and are now living on lands belonging to church officials, *votchinniki* [hereditary landowners], and *pomeshchiki* [landholders in service to the czar] are to be returned to the Tsar's lands according to the land cadastres [a real-estate tax register] of 1626 regardless of the *urochnye leta* [a time limit on searching for and returning fugitive peasants]. . . .

10. A person who harbors another's peasants must pay the tsar's taxes and ten rubles per year for each peasant to make up for the plaintiff's lost income from the work of the peasant and must surrender the fugitive peasants to the plaintiff. . . .

22. Peasant children who deny their parents must be tortured. . . .

27. A peasant who is the subject of a suit and states that he does not belong to the defendant will be given to the plaintiff with all his own moveable property. He who is guilty of taking false oath must be severely punished, beaten with a whip around the market place for three days, and jailed for a year. . . .

Source: "The Law Code of 1649," excerpted in Readings in Russian Civilization, edited by Thomas Riha (Chicago: University of Chicago Press, 1964), pp. 175-178.

process commenced during the Moscow Civil War of 1433 to 1450, when Michael Andreyevich, the appanage prince of Beloozero and Vereia and a loyal ally of Muscovite grand prince Vasily II, decreed that peasants residing on lands of Kirillov and Ferapontov monasteries could leave only during the week before and the week after Saint George's Day (November 26), which marked the traditional end of Russia's agricultural season.

Probably issued at the request of Grand Prince Vasily, who wanted to maintain the support of key Orthodox monasteries against rival claimants to the throne, Prince Michael's decrees established a precedent that soon became applicable first to all monastery peasants and ultimately to all peasants living in the territories of the Muscovite

state. This precedent became law in Ivan the Great's Code (*sudebnik*) of 1497, which reiterated, this time explicitly, restrictions on peasant movement. The *sudebnik* of 1497 further established that peasants could depart only after having given prior notice, having cleared up any existing debts, and having paid an exit fee determined by the length of time the peasant in question had been resident on the land.

Although Czar Ivan the Terrible's Code of 1550 also reiterated the provisions of 1497 (and of the mid-fifteenth century decree of Michael Andreyevich), the Muscovite state placed no new limitations on peasant mobility during the first three-quarters of the sixteenth century. Moreover, there is evidence that many peasants ignored the existing provisions, moving at their own discretion without paying off existing debts or the compulsory exit fee, or both. Still, as long as peasant movement had no adverse impact on the interests of the Muscovite state, Muscovy's rulers showed no genuine concern to restrict where or when peasants could be mobile. However, once peasant movement, both legal and illegal, began to affect the state in an adverse fashion, which it did during the late 1570's and early 1580's, Moscow's czars were quick to respond.

In 1581, Ivan the Terrible, whose disastrous domestic and foreign policies produced major chaos and dislocation within the Muscovite state, declared the first so-called Forbidden Year, prohibiting peasant movement for one year, even during the Saint George's Day period. Many historians believe this was Ivan's response to the flight of a significant amount of peasants from the estates of the middle service-class cavalrymen. The cavalrymen, by the end of the sixteenth century, became the backbone of Muscovy's army. They could not fulfill their military obligations to the state without peasant labor on their land. Also losing peasant labor were the estates of the wealthy and powerful magnates (boyars) as well as the church. Although the Forbidden Year of 1581 was intended to be a temporary expedient, the Muscovite state renewed it annually until 1592, when the government of Czar Fyodor I issued an even stricter decree that prohibited all peasant movement until further notice.

Five years later, in 1597, Fyodor's government established a statute of limitations that gave landlords the right to seek out and reclaim peasants who had run away within five years of the decree's issuance. The legislation establishing the statute of limitations declared that fu-

gitive peasants, their families, and their personal (movable) property be returned to their former residences. Yet, the law simultaneously stated, explicitly, that peasants who had fled more than five years before the decree was issued could not be made to return to their former residences if no formal complaint had been made to the appropriate authorities. Also, the seigniors who had received these peasants could not be prosecuted.

Russia's catastrophic Time of Troubles (1584-1613), which featured ongoing dynastic crises, social unrest, rebellion, and foreign invasion, promoted a renewed increase in significant peasant flight from landed estates in general and the estates of the middle service-class cavalry in particular. Once again, Muscovy's rulers responded to the plight of its military servitors (servants). In 1607, Czar Vasily Shuysky issued a decree extending the statute of limitations to fifteen years and imposing fines on any landlord, including the church, who gave refuge to fugitive peasants. Henceforth, any landlord found guilty of harboring a fugitive peasant had to pay the czar ten rubles for each fugitive discovered on his land. In addition, the landlord had to pay the peasant's rightful seignior three rubles for each year the fugitive in question had been given refuge. The evidence suggests that Shuysky's decree did little to halt the flight of peasants, who simply ignored all restrictions on their freedom of movement and relocated, taking maximum advantage of the chaos that reigned in Muscovy. Moreover, by 1613—the end of the Time of Troubles and the election of Michael Romanov as Russia's new czar—the statute of limitations had reverted to the five-year period first established in the legislation of 1597.

The Muscovite state's provisions on peasant movement remained unchanged until the late 1630's, when a new increase in peasant flight and the concomitant concern for the middle service-class cavalry led to renewed governmental measures to restrict peasant mobility. Serving as a catalyst was the cost of Muscovy's Smolensk War (1632-1634) against Poland, which required a tax increase that fell disproportionately on the peasants. Faced with a heavier tax burden, many peasants fled, a development adversely affecting the cavalry, whose representatives, yet again, petitioned the government for assistance. In response, Czar Michael raised the statute of limitations to nine years in 1637 and to fifteen years in 1642. Ultimately, in 1645,

the czar even promised to repeal the statute completely as soon as the new census, scheduled for 1646-1647, was completed. Though Michael died shortly thereafter and thus could not fulfill his promise, his successor, Czar Alexis, appointed in 1648 the commission that produced the codification of serfdom found in the 1649 Ulozhenie.

SIGNIFICANCE

The Ulozhenie of 1649 effectively legalized serfdom. It prohibited peasants and their descendants from legally leaving the lands of the landlord with whom they were registered. A famous, brutal uprising of peasants, led by Don Cossack leader Stenka Razin, occurred between 1667 and 1671 and has become legendary. Serfdom as it was codified by Czar Alexis would remain a fundamental feature of Russia's society and economy until it was abolished by Czar Alexander II (r. 1855-1881) on February 19, 1861.

Bruce J. DeHart

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■ APRIL, 1652

DUTCH MAKE CAPE OF GOOD HOPE AN AGRICULTURAL COLONY

Dutch colonization of Southern Africa began with the establishment of a provisioning station for ships of the Dutch East India Company, thus beginning European settlement in the region. The colony would ultimately displace and dominate the indigenous people of the region.

LOCALE: Cape of Good Hope, Southern Africa

AGRICULTURAL ISSUES: Cattle keeping; European colonization; Migration; Slavery

KEY FIGURES

Autshumao (d. 1663), member of Khoikhoi, or Hottentot, group who acted as interpreter for the Dutch

Doman (d. 1663), Khoikhoi revolt leader against Dutch in 1659

Krotoa (d. 1674), a young Khoikhoi woman who influenced trading patterns between Dutch and indigenous peoples of Southern Africa

Simon Adriaan van der Stel (1639-1712), governor of Cape Colony, 1679-1699

Willem Adriaan van der Stel (1664-1733), governor of Cape Colony, 1699-1707

Jan van Riebeeck (1619-1677), first commander of Dutch South African colony, 1652-1662

SUMMARY OF EVENT

European explorers first rounded the Cape of Good Hope in 1487 when Portuguese explorer Bartolomeu Dias sailed into the Indian Ocean. Portuguese explorer Vasco da Gama successfully completed his voyage to India in 1498 and established a direct trade route between Europe and India by sea. This brought an increasing number of ships from many nations to the southern tip of Africa.

During the sixteenth century, English, Dutch, and French ships stopped at the Cape of Good Hope for food and water on their way to

India and on the return voyage. Terrible mortality rates of sailors on long voyages had led Europeans to discover that fresh fruit and meat would improve their health. This made the cape a critical location where they traded with the local Khoikhoi bands who raised cattle and farmed the region.

In 1649, some Dutch sailors who were stranded after losing their ship spent a month at Table Bay near the Cape of Good Hope. Upon their return to Holland, they recommended that the Dutch East India Company annex the peninsula. In 1652, the company sent Jan van Riebeeck and eighty employees to take possession of the territory, which they did in early April. Their purpose was to build a fort and to obtain fruit, meat, and vegetables for Dutch ships. The colony was to be directed by a commander, later governor, and a council of policy, made up of high-ranking company officials. They were subject to the control of the governor-general of the Dutch East India Company in Batavia (now Jakarta, Indonesia). The governor of the Cape Colony could appoint local members to governing bodies, and even church offices were appointed by the governor. This direct control by company officials reflected their desire to support trade to the Indies rather than the establishment of a large Dutch community.

The company directors gave strict orders to maintain peace with the African peoples and other Europeans at the cape. The Dutch commander was to focus on trade. Good relations between the Khoikhoi and the Dutch were maintained through barter, as the Africans were willing to trade cattle and food for iron implements and European manufactures they lacked. Tensions among the various Khoikhoi communities were exploited by the Europeans. One member of an outcast group of Khoikhoi was Autshumao, named Harry by the English who took him to Java in 1631. There, he learned English, and when returned to his people at the cape, he became an important link in the trading network between his band and the English, then the Dutch. Harry's niece, Krotoa, was taken into the home of Commander van Riebeeck. Krotoa was renamed Eva and was raised as a member of van Riebeeck's family. She adopted Christianity and became fluent in Dutch, acting as interpreter as well as an unofficial agent for her people's commerce with the Dutch.

Although van Riebeeck bartered for cattle and grew some vegetables to provision Dutch ships in 1653, the colony was unable to sup-

port itself entirely. Staples, such as rice and wheat, had to be imported. The increasing costs associated with the colony led company directors to permit nine employees to be released from their contracts in 1657. Each was given approximately 28.5 acres of land to farm. The company expected to save by reducing salaries and to benefit from the crops they would grow, which would be sold to the company at a fixed cost. These settlers were exempt from taxes for twelve years and permitted to trade directly with the Khoikhoi for cattle as long as they did not compete with the company.

These first “free burghers,” or Boers (Afrikaners), whose number had grown to forty by 1662, changed the nature of European settlement in two ways. First, they took land from indigenous peoples and made it unavailable for livestock, on which the local inhabitants depended for their livelihood. Formerly willing to engage in trade with the Europeans, the Khoikhoi became alarmed at this encroachment. Doman, a member of the Goringhaiqua Khoikhoi, had been taken to the Dutch East Indies in 1657, where he learned Dutch. He also saw how the Dutch treated the local peoples they dominated. After returning to the Cape Colony, ostensibly as interpreter for the Dutch, he rallied the Khoikhoi to attack the farms and crops of Dutch settlers in 1659. Negotiations averted further hostilities but did not permanently resolve the issue of European expansion at the expense of the Khoikhoi. From that moment on, Dutch settlers would continue to expand their control over the land, first around Cape Town, and then throughout all of Southern Africa.

The second way in which these Dutch settlers changed the history of South Africa was their need for labor. The first commander of the colony, van Riebeeck, had asked for slave labor as early as 1653. His request was refused. Nevertheless, the growth of the colony and the injunction against enslaving the indigenous peoples made the need for labor increasingly important. The first slaves arrived in 1658 aboard a Dutch ship that had captured a Portuguese slave ship and its cargo. Other slaves were imported from West Africa and Madagascar. Later, slaves came from the East Indies and Southeast Asia, all indiscriminately called Malays. The eventual mixing of Europeans and indigenous populations produced a new group in South Africa that was neither wholly African nor European, and yet would become an important part of South African society.

SIGNIFICANCE

The Dutch colony expanded slowly at first, but the arrival of French Huguenot refugees, Calvinist Protestants who had been expelled from France with the revocation of the Edict of Nantes in 1685, added more than 150 new colonists to the population. By the early eighteenth century there were nearly three thousand men, women, and children, including slaves and company employees. With the leadership of Governor Simon Adriaan van der Stel and his son Willem Adriaan van der Stel, his successor as governor, farms began to spread outward from the cape. The new settlers extended Dutch settlement and also helped create the image of the Trekboers as pioneers conquering an empty wilderness. For the Khoikhoi, though, European expansion led to the destruction of their way of life. They fought back valiantly but were defeated. The great 1713 smallpox epidemic further devastated the Khoikhoi of the Cape area. The various



Modern vineyard near Stellenbosch, a town founded by the Dutch about thirty miles inland from Cape Town in 1679. Most of South Africa's Cape region is too arid for intensive agriculture, but the area immediately around Cape Town is prime agricultural land. Buildings in this picture reflect the architecture of the early Cape Dutch period.
(©Bigpressphoto/Dreamstime.com)

indigenous groups finally lost their clan structure and were thereafter indiscriminately referred to as “Hottentots” by Europeans.

The destruction of African tribal society was paralleled by the creation of a new society created by European immigrants to Dutch South Africa. French Huguenot refugees were purposefully separated and interspersed among the earlier Dutch settlers to integrate them. The establishment of schools by the company at Stellenbosch in 1686 and Drakenstein in 1691, while educating only a small number of the boys and girls in the colony, did help instill a common background and language among the immigrants. The doctrines of the Calvinist church, shared by most European immigrants, also helped to create an Afrikaner culture that was unique to South Africa. This Afrikaner society, as it came to be called, along with its Dutch-derived local language, Afrikaans, remains an influential part of South African history.

James A. Baer

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PORTUGAL RETAKES BRAZIL AND EXPANDS ITS ECONOMY

Expelling Spanish and Dutch usurpers, Portugal reasserted its control of Brazil, which became the richest element of the Portuguese Empire. Brazil exported more sugar and imported more African slaves than any other country.

LOCALE: Brazil

AGRICULTURAL ISSUES: European colonization; Marketing and trade; Migration; Slavery; Tropical produce

KEY FIGURES

Salvador Correia de Sá e Benevides (1594-1688), Brazilian-born governor who was crucial in reasserting Portuguese control of West African slave-trading posts and south Atlantic trade

Antônio Vieira (1608-1697), a leading Brazilian Jesuit orator, writer, and government adviser

Antônio Raposo Tavares (c. 1598-1658), São Paulo official who led numerous, wide-ranging expeditions that expanded colonial frontiers in Brazil

SUMMARY OF EVENT

The Dutch had occupied the northeastern part of Brazil since 1630, but from the mid-1640's until 1654, an alliance of local Brazilian landowners and the Portuguese finally drove the Dutch from what was named New Holland. Portugal had lost its sovereignty in 1580 when the king of Spain, Philip II, became king also of Portugal. The Spanish occupation of the Portuguese throne continued until 1640, when Portugal reasserted its independence.

Portugal regained sovereignty over Brazil in 1654, a country that was much changed since the previous century. Before 1580, Brazil had been a minor component of the Portuguese Empire, the center of which was the wealth of India and Southeast Asia. Incipient sugar plantations, along its northeast coast, were Brazil's only source of wealth for Portugal. Indian slavery failed as a labor supply, but more

successful was the importation of slaves from Portugal's advancing possessions along the western coast of Africa, especially Ghana and Angola. Angola provided the greatest number of slaves. "Sugar is Brazil and Brazil is Angola" was a common expression of the time.

The modest but steady prosperity of Brazil's sugar-exporting economy meant that its white immigrant population of about 25,000 people at the beginning of the seventeenth century had grown to almost 100,000 by century's end. Disease as well as defeat by European arms reduced the indigenous population from several million to several hundred thousand, but the African slave population grew most spectacularly. Several hundred thousand Africans were transported to Brazil, arriving at an annual rate of more than one thousand at the beginning of the century to nearly ten thousand by the end of the century.

African slave labor was instrumental to the success of the sugar plantations and mills. Brazil, the largest exporter of sugar during the century, produced more than 1,500 tons at the beginning of the period to almost 400,000 by century's end. Ensuring this success was the more than four hundred sugar mills in Brazil by century's end. Also ensuring success was the huge number of slaves working in the mills, who were "distributed" primarily in three provinces: Pernambuco, Bahia, and Rio de Janeiro. Pernambuco, the richest sugar-producing region, had more than half the mills and plantations. Bahia, the colonial capital of Salvador, was second in the number of mills. However, Rio de Janeiro had developed many more mills, so that by the end of the seventeenth century, Bahia and Rio de Janeiro each held one fourth of the mills. Brazil did not have a monopoly on sugar production. Islands of the Caribbean became major competitors.

The economic preeminence of Brazil within the Portuguese Empire grew steadily. At the beginning of the seventeenth century, the empire's wealth from Brazil was inferior to that gained from the trade in spices and luxury products from Portuguese colonies in India and East Asia. By the middle of the century, its energy and resources depleted by wars against Spain and the Netherlands, Portugal had lost many of its eastern realms, so Brazil's agricultural wealth became the economic backbone of the empire. Indeed, Brazil became so crucial to Portugal that after 1645, the heir to the Portuguese throne bore the title prince of Brazil.

Brazil's agricultural wealth was distributed within a rigid hierarchical society. A small number of white plantation owners dominated a mass of enslaved Africans. The owners of the sugar mills were those who owned the vast landholdings known as *latifundia*. These owners were the *senhores de engenho*, the lords of the mills. They dominated Brazilian government and society. Family, slaves, leaseholders of small farms, clergy, and craftspersons were their subordinates. A shortage of white women in early colonial Brazil resulted in abundant interracial coupling among whites, blacks, and indigenous peoples. Brazilian culture was dominated by the Catholic clergy, particularly the Jesuits, whose greatest spokesperson during the period was Father Antônio Vieira, a preacher and scholar.

Brazil's government administration was handled by a Portuguese governor-general, who was located in Salvador. Occasionally, he was referred to as a viceroy, depending on the individual's aristocratic background. The northern coast of Brazil was administered as a separate state, Maranhão, with its capital at São Luis. Dual administration was necessary because the territory of Brazil straddled the equator. Consequently, navigation to and from the country depended on two different sets of ocean winds and currents. In the south, the two most important regions were Rio de Janeiro and, farther south, São Vicente and its satellite city in the coastal highlands, São Paulo. One of the governors of Rio de Janeiro, Salvador Correia de Sá e Benevides, had been crucial in reestablishing Portuguese control in the south Atlantic after he recaptured the African colony of Angola from the Dutch.

São Paulo was to be crucial to the geographic expansion of Brazil. Its residents, called *paulistas*, organized bands of frontiersmen, known as *bandeirantes*. Moving along the rivers of the interior of Brazil that coursed south, west, and north, they raided vast regions of the interior, hunting for indigenous slaves, gold, emeralds, and diamonds. One of the most famous *bandeirante* adventurers was Antônio Raposo Tavares. *Paulistas* moved along a vast area that closely resembles Brazil's modern physical contours (from the Uruguay River in the south to the mouth of the Amazon River in the north). It would be one of the *bandeirantes* who discovered gold in central Brazil in 1695. This discovery led to the largest gold rush in the world in the eighteenth century and also led to the definitive occupation of the Brazilian interior.

SIGNIFICANCE

Brazil was the key component of the Portuguese Empire in the seventeenth century, and its recapture from the Dutch served the empire well. Although sugar production predominated, Brazil also mined gold and diamonds and exported brazilwood (a red dyewood often used for cabinetmaking), cotton, and tobacco. It also exported slaves, and its cattle industry exported meat and hides. Two monopolizing trading fleets thrived, beginning in 1649 with the Commercial Company of Brazil and the Maranhão Company, which formed in 1682. Because of their monopoly, the companies were opposed by many, and they were abolished during the early eighteenth century.

In terms of land, labor, resources, and economy, Brazil was a sociocultural phenomenon that straddled a vast space: the south Atlantic from the coast of eastern South America to the coast of western Africa.

Edward A. Riedinger

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POPULARITY OF CHOCOLATE INCREASES CACAO PLANTING

The introduction of cocoa as a commodity in seventeenth century London quickly gave rise to a “chocolate culture” in Europe. The new luxury item, imported from the New World, provided the fundamental economic underpinnings by which imperialism would eventually grow, especially in Africa.

LOCALE: London, England

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Marketing and trade; New crops and food products; Tropical produce

KEY FIGURES

Anne of Austria (1601-1666), queen of France, r. 1615-1643, and queen regent, r. 1643-1651, who introduced chocolate to the French court

Christopher Columbus (1451-1506), Genoese explorer credited with first bringing chocolate to Europe

Hernán Cortés (c. 1485-1547), Spanish conquistador who popularized chocolate in Spain

SUMMARY OF EVENT

As a beverage, chocolate has been drunk for thousands of years. However, Europeans never realized chocolate existed until Christopher Columbus returned from his fourth voyage to the New World in 1502 with the dark brown beans that were promptly set aside in favor of silver and gold. Little did those at the Spanish court realize that these beans were used as native currency or that they were destined to become one of the world’s largest agricultural crops. Their consumption would create enormous wealth for individuals and for governments alike.

Cacao is the name of the plant that produces cocoa beans, and chocolate, referred to by the early Mexicans as the “food of the gods,” is an end product of the cocoa bean. Solid in form, it was diluted with hot water to make a drink known as *xocolatl*, which was served to the



Early twentieth century Trinidadian workers sorting cocoa beans. (Library of Congress)

Aztec emperor Montezuma, who was rumored to have drunk fifty cups daily. The drink was consumed as a hot liquid, its harsh bitter taste softened with sugar and vanilla. The Spanish explorer and conquistador Hernán Cortés, who conquered the Aztecs in 1521, saw great possibilities in the cultivation of cacao: When Cortés returned to Spain in 1528, he loaded his galleons with cocoa beans. Spain kept the source of chocolate a secret for almost a century. In fact, in 1579, when English pirates boarded a Spanish galleon in search of gold and mistook cocoa beans for sheep's droppings, they burned the ship and its incredibly valuable cargo.

Because of Spain's trade monopoly with the New World, chocolate remained exclusively Spanish until the seventeenth century, when Anne of Austria married Louis XIII in 1615 and introduced the culture of coffee to the French court. It was met with skepticism, however, and came to be accepted only after medical approval. Meanwhile, the French practice of chocolate drinking reached England by the mid-seventeenth century. In 1650, the practice was introduced at

the university town of Oxford, and in 1656, “The Coffee Mill and Tobacco Roll,” the first shop to serve chocolate, was opened in London by a Frenchman. In 1659, an advertisement for chocolate—one of the first advertisements for a commercial product in Britain—appeared in an English newspaper.

Chocolate was associated with the rich, as a status drink, for the next two hundred years. A sixteenth century Spanish historian by the name of Oviedo wrote: “None but the rich and noble could afford to drink *xocolatl* as it was literally drinking money.” Sold in blocks, it could be grated or scraped into a cup or saucepan before adding hot milk or water. Although these solid cakes were sold for home use, in England the chocolate drink was consumed primarily in chocolate houses, which during the seventeenth century grew to be as prominent as coffeehouses. Just as they did in coffee houses, the wealthy met in chocolate houses to smoke tobacco, discuss political events and literature, and conduct business. In 1693, Italian immigrant Frances White opened White’s Chocolate House, London’s most famous, and possibly most notorious, chocolate house, on St. James Street. The famous diarist Samuel Pepys, in one of his entries, refers to “Mr. Bland’s,” where he was in the habit of taking his “morning draft of chocollatte.”

While coffeehouses in England took on a puritanical character, chocolate houses came to be associated with aristocrats, politicians of questionable repute, the literati, and gamblers. Also, since chocolate was associated with Catholic Spain, the British—by this time heavily Anglican and Protestant following the Puritan interregnum of Oliver Cromwell—considered chocolate to be a decadent drink. For a while, chocolate was considered an aphrodisiac and was believed to enhance fertility in women. Therefore—as it had done with coffee, tea, and tobacco before it—Parliament began to regulate the consumption of chocolate by imposing enormous taxes. Nevertheless, the drinking of chocolate grew in popularity, especially among the well-to-do.

European aristocrats were fond of chocolate in the morning, served on small tables in the bedroom and oftentimes in bed. While caffeinated coffee and tea provided an early-morning physiological jolt to middle-class workers, chocolate, which contains less caffeine, ensured the rich a leisurely entrance into an unhurried day. Porce-

lain pots, called chocolate pots, and special cups were designed specifically for the popular new drink. The aristocratic practice of drinking morning chocolate with one's friends soon became a popular theme for seventeenth century artists.

After its introduction into England, chocolate mixed with hot milk was often served after dinner as a form of dessert. Eventually, however, the popularity of chocolate as a daily drink in England was usurped by coffee. Interestingly, it seems coffee as a beverage of choice permeated the Protestant countries—England, the Netherlands, and France—whereas chocolate remained popular in Catholic southern Europe, especially in Spain and Italy. Its rich nutritional value ensured chocolate's continued favor in the Catholic south, since chocolate could "safely" be served as a food substitute to penitents during periods of physically uncomfortable fasts.

SIGNIFICANCE

The rapid spread of chocolate consumption helped prompt the spread of imperialism throughout Europe during the colonial age. In the seventeenth century, the Dutch broke Spain's monopoly on cocoa beans when they captured Curaçao and brought cocoa beans from the New World to the Netherlands, where the drink rapidly grew in popularity. The French trade in chocolate spread similarly after France conquered Cuba and Haiti during the later half of the seventeenth century and began growing cacao in New World plantations.

Although initially chocolate was used solely by the rich, the conquest of Jamaica by the British during the middle of the seventeenth century assured direct access to cacao production and enabled the trade to spread and grow in popularity in Great Britain. Cocoa was used as money in this era: One hundred seeds could be used to purchase a slave.

In this era, too, the Quakers, a pacifist religious sect, advocated the use of chocolate as an alternative to alcohol among the general British population. Members of Quaker families named Cadbury, Fry, and Rowntree held a monopoly on chocolate making in Britain. They emigrated to colonial America, primarily to Pennsylvania, where the Hershey's Chocolate Company is still located.

Eventually, cocoa production changed as Europeans began to col-

onize Africa. Production decreased in the Caribbean and South America as a new cocoa industry took effect in Africa. In the twenty-first century, African nations are among the world's leading producers of chocolate. Thus, the European craving for chocolate played a major role in imperial acquisition and colonial expansion.

M. Casey Diana

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■ MARCH 24, 1663-JULY 25, 1729

TOBACCO AND SUGAR FARMING BEGIN IN THE CAROLINAS

The Carolinas became the seat of the South in British North America, central to the tobacco and sugar plantation culture that the colonists developed and to the slave trade necessary to support that culture.

LOCALE: Eastern Carolinas

AGRICULTURAL ISSUES: European colonization; Migration; New crops and food products; Slavery

KEY FIGURES

Sir William Berkeley (1606-1677), governor of Virginia, 1641-1649, 1660-1677, and an original Carolina proprietor

John Colleton (fl. 1663), wealthy Barbadian planter who took the initiative in acquiring the proprietary charter for the Carolinas

John Culpeper (1644-1691/1694), leader of a rebellion against Albemarle's proprietary government

William Drummond (d. 1677), first governor of Albemarle County, 1664-1667, which became North Carolina

Edward Hyde (c. 1650-1712), first governor of North Carolina independent of South Carolina, 1711-1712

John Locke (1632-1704), English political philosopher, who helped to prepare the Fundamental Constitutions

Philip Ludwell (c. 1637-after 1710), first governor of both Carolinas

First Earl of Shaftesbury (Anthony Ashley Cooper; 1621-1683), proprietor and architect of the Carolina proprietary system

Sir John Yeamans (1611-1674), leader of South Carolina's Goose Creek faction

SUMMARY OF EVENT

The origins of English settlement of the Carolinas can be traced to 1629, when Charles I of England granted all land between 31° and 36° north latitude to Sir Robert Heath, who called the area "New Carolana." Heath planned to open the territory to French Protes-

tants, or Huguenots, who were under siege during the latest of French religious conflicts. Agents of the Carolina settlers attempted to obtain supplies in Virginia to the north but were largely unsuccessful, and no settlements were established. Heath shortly thereafter gave up on the enterprise, and nothing further was attempted during Charles I's reign.

The introduction of large-scale sugar production during the early 1660's to Barbados, in the West Indies, among the wealthiest of the English colonies, had forced many small English planters to consider emigration from the island. When Sir John Colleton, a wealthy Barbadian, returned to England and gained a seat on the Council for Foreign Plantations, he conceived the idea of establishing a proprietary colony and recruiting Barbadians to settle it. For fellow proprietors, Colleton turned to powerful Englishmen who had already been associated with colonial expansion, the first earl of Shaftesbury, Sir William Berkeley, John Lord Berkeley, George Monck, the first earl of Clarendon, the earl of Craven, and Sir George Carteret. On March 24, 1663, King Charles II granted to the proprietors a charter similar to that granted by his father, redefined as all land between 29° and 36°30' north latitude and extending west to the "South Seas"; they called the area Carolina after King Charles.

Required only to pay a nominal annual sum to the king, the proprietors possessed vast powers. They were empowered to fill offices, erect a government, establish courts, collect customs and taxes, grant land, confer titles, and determine military matters. They were obliged to guarantee the rights of Englishmen to their settlers, however, and could enact laws only with the consent of the freemen. The proprietors in England also constituted a Palatine Court, which, in addition to appointing the governor of the colonies, was empowered to disallow laws and hear appeals from the colony.

Having devised plans for the creation of three counties and having begun negotiations with two groups of prospective settlers in Barbados and New England, the proprietors drafted the "Declaration and Proposals to All That Will Plant in Carolina," which outlined a headright system of land distribution and a framework for participatory government. Sir William Berkeley received authorization to appoint a governor and council for Albemarle County (later North Carolina), and in October, 1664, he named William Drummond of

Virginia as its governor. A few months later, Sir John Yeamans was commissioned governor of Clarendon County. As a further inducement to settlement, in January, 1665, the proprietors drew up the Concessions and Agreements, which provided for a unicameral legislature that included representatives of the freemen and ensured religious toleration. However, friction between new arrivals and original settlers, in combination with hostility from Native American tribes and the news of better land to the south, led to the abandonment of Clarendon County in 1667.

Settlement of Carolina during this period was focused primarily on the estuaries of the southern regions rather than the large bays and dangerous banks of the north. Settlers in the region were a varied lot, consisting of a mixture of English Dissenters, French Huguenots, and Presbyterian Scots. The largest contingent, however, consisted of emigrants from Barbados; by 1671, they constituted half the population in the region.

As a system of laws, the Concessions and Agreements had proven unsatisfactory, so in 1669, the earl of Shaftesbury collaborated with his protégé, John Locke, to write the Fundamental Constitutions of Carolina. Essentially, the program called for development of a landed aristocracy for the region, in the form of 12,000-acre (4,850-hectare) baronies. Two-thirds of the land would be held by a colonial nobility. Although a "parliament" consisting of the nobility and popular representatives would sit in the colony, the proprietors in England, functioning as a Palatine Court, could veto the legislature's decisions. Some of these provisions were implemented, but the proprietors never succeeded in winning approval of the system as a whole. Few baronies were ever surveyed, and no manorial system was ever established. Reflecting the exigencies of a governing body in England removed from the day-to-day running of a colony, the actual government consisted of a governor and council appointed by the proprietors and representatives elected by the freemen. Until a Supreme Court was established in 1700, the governor and council would constitute the colony's highest court.

Despite the abandonment of the Clarendon region, Carolina's proprietors continued to develop plans for settlement of the region. Shaftesbury was able to convince the proprietors that a larger investment was essential for success. Drawing upon earlier experience and

the expertise and resources of investors from Barbados, it was decided to attempt to establish a settlement at Port Royal. More than one hundred settlers, led by Joseph West, left England in August, 1669. However, after landing at Port Royal, already an important anchorage, they were persuaded by the local tribes to travel to another estuary some sixty miles up the coast. There, in April, 1670, they established Charles Town (modern Charleston).

Because the settlers were predominantly tradesmen ignorant of farming methods, many went into debt and deserted the colony. Recruitment efforts proved successful, however, and a rapid influx of settlers from Barbados and elsewhere continued to populate the colony. Many of these men moved inland, searching out the best land along the estuaries. They quickly learned the ways of agriculture. Disparate ethnic enclaves began to form, such as French Huguenots settled along the Santee and a Scottish settlement at the anchorage of Port Royal. Despite religious contention, prosperity within the colony increased. In 1674, Dr. Henry Woodward was commissioned Indian agent to establish trade with local Native American tribes; the



Field workers cutting and stacking tobacco leaves before taking them to be cured. (Library of Congress)

colonists developed a thriving trade in furs and naval stores with England and in meat, lumber, and Indian slaves—a practice frowned upon by the proprietors—with the West Indies.

A large proportion of the colonists having emigrated from Barbados, this particularly significant group soon gained control of the government. Known as the “Goose Creek men,” from the site of their settlement just outside of Charles Town, this faction was to determine the colony’s politics for the next fifty years. Despite success in the areas of trade and farming, conflict between the proprietors and settlers over debts, land distribution, and the slave trade nearly brought an end to the colony during the 1670’s. Attracted by the proprietors’ promise of toleration, many Dissenters also came, only to encounter the resentment of the conservative Anglican Barbadians, who resisted the proprietors’ efforts at reform; both pro- and anti-proprietary factions were formed.

During the 1670’s, dissension culminated in what became known as Culpeper’s Rebellion. In 1677, Thomas Miller, governor and leader of the proprietary faction, attempted to combine his position with the duties of customs collector. In December, an anti-proprietary faction established a revolutionary government and imprisoned Miller. Miller escaped to England and pleaded his case before the Privy Council; John Culpeper, a leader of the dissident group, represented the rebels. The council decided that Miller had indeed exceeded his authority. Culpeper was tried for treason but through the influence of Shaftesbury was acquitted.

When Governor James Colleton declared martial law in February, 1690, in an attempt to halt the abuses of the Native American trade and collect the quitrents, the Goose Creek men ousted him and replaced him with Seth Sothel. In 1691, Sothel was suspended by the Palatine Court and charged with treason, though Sothel’s death in 1694 ended the controversy. Meanwhile, Philip Ludwell was appointed governor by the proprietors (1691), and the popular free-men’s branch of the legislature was allowed to meet separately and to exercise parliamentary privileges.

Unlike the turmoil of earlier decades, the 1690’s would be a decade of relative peace and prosperity. Ludwell and his successors were to reside in Charles Town, while Albemarle County, governed by Ludwell’s deputy, was to retain a separate legislature. Trade with Na-

tive American tribes prospered. Perhaps even more important, during this period it became apparent that a new crop, rice, was perfectly suited for the swampy lowlands of Carolina. Rice quickly became a staple export. Critical to the development of rice farming was the large influx of African slaves into the region, bringing with them knowledge of rice cultivation. By the beginning of the eighteenth century, the black population equaled that of the white: There were approximately four thousand of each race.

The region of Albemarle, known as North Carolina after 1691, was repeatedly torn by religious strife in the first decade of the new century. Huguenots from Virginia had settled the area south of Albemarle Sound; German Palatines and Swiss had settled in the region of what would be founded as New Bern (1710). Although toleration had prevailed in the earlier years and many Dissenters held positions of power, Anglicans were determined to establish the Church of England in the colony. With the passage of the Vestry Act of 1704, Assembly members were required to take an oath of loyalty to the Church of England. The act aroused such intense opposition that deputy governor Thomas Cary was removed for attempting to enforce the law. In 1712, North Carolina was established as a separate colony; the proprietors appointed Edward Hyde deputy governor, the first governor of North Carolina to be independent of the royal governor of Carolina. The new legislature nullified the laws of the previous administrations.

SIGNIFICANCE

The Carolinas were thus a crucible for many of the controversies shaping the evolution of both the colonists' home countries and the other English colonies. Religious strife, disagreements over the proper form of colonial government and over the role of government as such, and interrelations between Europeans, Native Americans, and African slaves, all came to a head in the Carolina colonies.

The crisis in North Carolina was exacerbated by the war with the Tuscaroras, the worst Indian war in the colony's history. In September, 1711, the Tuscaroras, seeking revenge for encroachment by the settlers on their land, enslavement of their people, and unfair trading practices, attacked New Bern and other settlements from the Neuse to the Pamlico rivers. Before the raids were over, hundreds of

settlers had been massacred and their farms destroyed. Two expeditions, led by Colonel Jack Barnwell and Colonel James More in 1712 and 1713 and aided by men from South Carolina, finally defeated the Tuscaroras. Although the war had placed the colony in dire financial straits, it drew the people together, and they entered a new period of peace.

The choice of rice as a staple crop had its greatest impact in the south. Unlike the tobacco crop, grown in the region of the Chesapeake to the north, rice growing required special water facilities to maintain an annual flooding of the fields. However, once the facilities were established, the rice crop could be grown in the same fields year after year. It was unnecessary to plant new fields or to continue shifting the settlements themselves. Thus, the settlements, once established, could maintain a semblance of stability, except for the frequent internal rivalries. Consequently, settlement followed the river systems as extensions from the city of Charles Town. By 1708, the population of the district (and in essence the entire colony) consisted of four thousand whites, forty-one hundred African Americans, and fourteen hundred Native Americans; most of the African Americans and Native Americans in the settlements were slaves.

Factional rivalries were revived at the beginning of the eighteenth century. The selection of an Anglican governor for Carolina in 1700 aroused the opposition of the Dissenters to the establishment of the Church of England in the colony; indeed, in 1704, the parish vestries had become the seats of power. The popular division over religion was superseded by a division over the issue of paper currency in 1712. As early as 1703, the colony had emitted its first bills of credit to pay for an expedition against the Spanish in Florida. Other emissions followed. The planters and tradesmen who did business solely within the colony favored the use of paper money, but the Charles Town merchants who had to pay their English creditors in specie bitterly opposed its use.

The proprietors had never moved decisively to control the long-standing abuses of trade with Native American tribes. As a result, in 1715, the Yamasee War, the longest and costliest war with Native Americans in South Carolina's history, erupted. During the conflict, people were driven from their homes to seek refuge in Charles Town. To end the abuses of trade, the Commons House of Assembly

created a monopoly of the Native American trade under its own direction.

In 1718, the proprietors launched a strong attack upon some of the colony's most popular laws, disallowing measures providing for bills of credit and import duties, removing the monopoly on trade, and weakening the power of the legislature; consequently, anti-proprietary sentiment crystallized in favor of royal government. All that lacked for rebellion was a catalyst.

The catalyst came in November, 1719, in the form of the rumor of an imminent invasion of the colony by the Spanish. When the assembly convened in December, it declared itself a convention and petitioned the Board of Trade to be made a royal colony. Because the region represented a major line of defense against both the French and the Spanish, King George I accepted the removal of the proprietary government, and South Carolina became a royal colony in 1719. The "royalizing" process also had its counterpart in North Carolina. The Crown bought out the proprietors on July 25, 1729, and North Carolina also became a royal colony.

Richard Adler

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■ 1689-1694

SHORT GROWING SEASONS CREATE FAMINE IN FRANCE

The economic downturn that began in France with the Wars of the League of Augsburg in 1688 was capped by a great famine. Killing up to one-tenth of the population, the famine combined with expensive warfare to empty the French government's treasury. It also convinced the Crown to step up its incarceration of the poor and of vagrants, and it exposed the weaknesses of the French economy and its tax system.

LOCALE: France

AGRICULTURAL ISSUES: Disease and health issues; Famine and hunger

KEY FIGURES

Louis XIV (1638-1715), king of France, r. 1643-1715

François Salignac de La Mothe-Fénelon (1651-1715), archbishop of Cambrai

Madame de Maintenon (Françoise d'Aubigné; 1635-1719), an educator and queen consort of Louis XIV

SUMMARY OF EVENT

The famine of 1693-1694 has seared itself into the social imagination as one of the worst events in French history. The weather had changed, marked by colder than usual temperatures for several years. It was the beginning of what historians have labeled a “mini-ice age,” when mean summer temperatures dropped by about one degree centigrade.

Beginning in 1692, however, a series of wet, cool summers and shorter growing seasons devastated the grain harvest. Wheat especially was left rotting or unripened in the fields, and the previous year's wheat supply was barely sufficient to hold off famine. The harvest of 1692 was terrible, and that of 1693 catastrophic. In Normandy, travelers and royal officials described corpses lying unburied along the roads, with those still alive subsisting on acorns and grass. With a weakened population and unhealthy food sources, intestinal disorder

ders, infections, and various pestilences sickened and killed many of the survivors. Between 1.3 million and 2 million men, women, and children, roughly one-tenth of the population, perished in less than three years. Historian Joél Félix has pointed out that the deaths were equivalent to the losses sustained by the French in World War I.

The regional, and even local, nature of subsistence crises like those of 1693-1694 cannot be overemphasized. France during the *ancien régime* was a collection of local economies, each circumscribed by the lack of transportation, roads, and regional markets. It was not unusual to find one village plunging into famine, while another scarcely thirty miles away was virtually unscathed. Subsistence crises in France were typically wheat crises. They were often less severe in areas such as coastal Brittany or the Mediterranean littoral, where fish made up a significant part of the diet, or in regions where buckwheat or chestnuts could be used for bread flour. Where wheat was dominant, though, especially in the cereal plains of the north, the crises could be fearsome. The more generalized crises of 1660-1661 and of 1693-



One of the most famous French paintings of the mid-nineteenth is Jean-François Millet's *The Gleaners* (1857), which depicts impoverished peasants searching for edible grain in a recently harvested field. (Hulton Archive/Getty Images)

1694 thus left some regions relatively untouched, while devastating others. Lower Languedoc and Brittany fared better than Normandy during the great famine of 1693-1694. Paris, with its powerful state officials and developed transportation system, did far better than many small cities and towns.

The economic crises of 1688-1694 and the great famine were also knit into larger demographic patterns in the seventeenth century. Since the Black Death of the fourteenth century had devastated the European population, subsistence crises and full-scale famines had recurred at irregular intervals. Population and resources remained in precarious balance, even though the long-term trend was one of slow population growth. The seventeenth century was, on balance, far worse than the sixteenth century had been. There had already been a previous, widespread famine at the outset of King Louis XIV's personal reign in 1661-1662. There were poor harvests and serious food shortages at the outbreak of the Wars of the Fronde (1648-1653), and yet another in 1698.

The subsistence crises provoked by nature were exacerbated, however, by human-made crises. The disorders and violence of the Fronde devastated large swaths of the French countryside. Steeply rising taxation from Louis XIV's wars placed increasing burdens on the peasantry, who paid the vast majority of French taxes through the *taille*, or hearth tax. Between 1688 and 1697, the Wars of the League of Augsburg stretched French finances and the tax burden to the breaking point. The league pitted the combined forces of the Habsburgs, the Dutch, and the English against French claims to new territory. The costs of prosecuting a war against so many opponents forced the king to collect tax revenues in advance from future years' taxation. The consequences in the countryside were plain to see. Increasing numbers of peasants fell into the class of landless or nearly landless laborers, while a few wealthy peasants concentrated more land into their hands.

The spiraling price of bread by 1692 also had a domino effect on the entire French economy. A typical family spent 50 percent to 60 percent of its income on bread alone; and when the supply failed, bread prices doubled and then quadrupled in many areas. As food prices escalated, the sale of cloth dropped off dramatically, throwing textile workers out of production. From cottage spinners and weavers

to the urban workshops of dyers, drapers, and finishers, their looms and workshops went silent. Since textiles and agriculture were the mainstays of the French economy, the ripple effect spread into other crafts and mercantile operations as well. This set off two apparently contradictory movements in the economy. When inflation struck bread prices, deflationary trends set into other sectors. Prices fell as demand fell for goods other than bread, and the economy as a whole became depressed. Deflationary, rather than inflationary, prices marked most of the reign of Louis, until after his death in 1715.

Ordinary people were far from passive in the face of recession, famine, and death. Local court records show that poaching increased in the countryside, along with food theft and begging; and both urban and rural commoners took to the streets in riots that alarmed authorities everywhere. The food riot was the most characteristic form of popular disturbance in early modern Europe. More than one hundred of them were recorded in 1690's France, in which women played prominent roles. These often took the form of angry mobs gathering at bakeries or mills, where they would insist that grain or bread be sold at what they considered a fair price.

The French state was more aware of the scale of the catastrophe than contemporaries gave them credit for, but their tools were limited. State charity scarcely existed in seventeenth century France, and private charity was insufficient to meet the crisis. François de Salignac de La Mothe-Fénelon, soon to be archbishop of Cambrai, sent a famous letter in 1694 to Louis XIV's second wife, Madame de Maintenon, for the king to see. "All of France is no more than a huge hospital," he wrote, "desolate and without provision." On October 20, 1693, the king had published an ordinance requiring each community to feed its poor, but wealthier residents often resisted the large contributions that were expected of them.

In the provinces, *parlements* issued decrees requiring bakers to sell bread, and they organized massive almsgiving to calm the food riots that were breaking out in every quarter. Nearly one-third of the population of Rouen received daily alms and thousands more begged at the height of the crisis. In Paris, the Louvre palace courtyard was converted into an enormous outdoor bakery, producing 100,000 loaves per day to be distributed to the poor. In their urgency to supply the cities and prevent widescale urban disorder, however, officials stripped

bare many rural areas and left the villagers to starve. One northern village recorded the deaths of 60 percent of its inhabitants in 1694 alone. The state's most permanent response was to incarcerate what it called the deserving poor and vagrants in state hospitals, reportedly to prevent disorder and theft.

SIGNIFICANCE

The famine of 1693-1694, and the subsequent losses to the French treasury from peasants who could no more afford to pay the *taille* than they could afford to feed themselves, added to the French state's fiscal woes. The mounting costs of the Wars of the League of Augsburg finally became insupportable. In September, 1697, the French and the Dutch negotiated the Treaty of Ryswick, ending the Nine Years' War. Louis XIV gave up many of his territorial conquests of the past thirty years, although he kept Strasbourg. The double burden of war and famine had proved too much for even Europe's largest state to sustain.

While famine stalked parts of France again in 1709-1710 (the famously cold winter in which it was said that wine froze in the king's glass at Versailles) and in 1740-1741, the years 1693-1694 saw the last great famine mortality in France. Population growth resumed, lands were brought back into cultivation, and communities slowly reconstructed themselves. Within a decade, the demographic losses had been recouped. However, the possibilities for disorder during food crises never were far from the minds of officials. French ministers were fitfully mindful of the need to build more roads and canals and to better understand the distribution of population and food, but there were too many other pressing demands upon state revenue in the eighteenth century. The poor harvest of 1788 would again help fuel popular unrest and bread riots in 1789, and would become one of many streams of discontent flowing into the French Revolution.

Zoé A. Schneider

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TULL'S SEED DRILL REVOLUTIONIZES FARMING

Jethro Tull's invention of the seed drill revolutionized farming. The drill replaced the wasteful and labor-intensive broadcast method of seeding and paved the way for subsequent advances in mechanized agricultural machinery.

LOCALE: Howberry, Crowmarsh (near Wallingford), Oxfordshire, England

AGRICULTURAL ISSUES: Draft animals; Innovations; Mechanization

KEY FIGURES

Jethro Tull (1674-1741), English agriculturalist and inventor

John Worlidge (fl. 1669-1698), early designer of a seed drill and the probable source of some of Tull's ideas

Gabriel Plattes (1600-1655), early patent holder for a seed drill that was never made

Taddeo Cavalini (fl. late sixteenth century), early Italian inventor of a seed drill that closely resembled Tull's

Henri-Louis Duhamel du Monceau (1700-1782), French agriculturalist, tree expert, and chemist

John Mills (d. 1784?), Englishman living in France who translated Monceau's work into English

SUMMARY OF EVENT

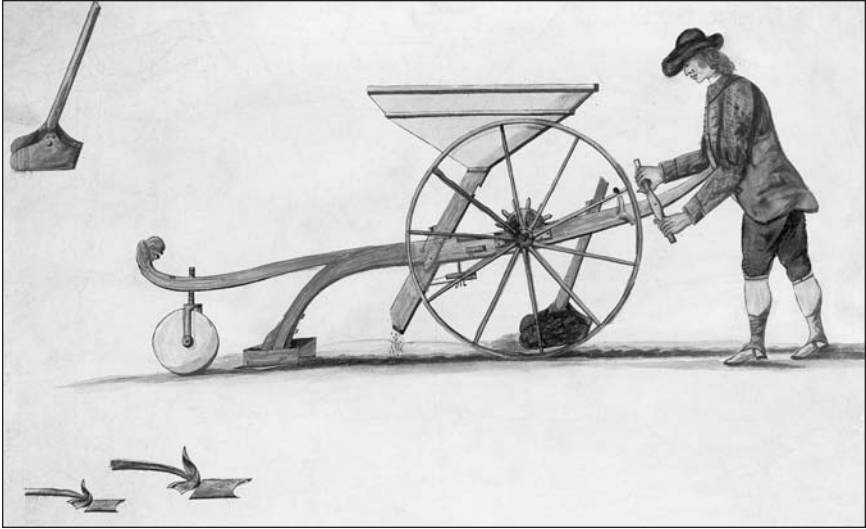
Seeding methods in early eighteenth century England were essentially those that had been practiced for thousands of years. Broadcasting was widespread. Workers walked over a field, casting seed in sweeping motions as they went. As a result, even with skilled broadcasters, a great deal of grain was wasted, and some parts of the field were sparsely covered while others were overseeded. While broadcasting could be used somewhat effectively with grains, the method was not appropriate for vegetables, which had to be planted in rows. Primitive seed-dropping devices were used with vegetables. Hand-dibbing was also used: One worker walked ahead, using a tube

with punches in it to make holes in the ground; another walked behind, depositing the seed in the holes and covering the seed with earth. A later improvement involved a tube attached to a primitive plow, but the flow of seeds still could not be regulated. In the sixteenth century, a setting board was used that allowed seeds to be dispersed three inches deep in the soil and at intervals of three inches.

Although Jethro Tull is acknowledged as the inventor of the seed drill, his was not the first seed drill to be designed. Taddeo Cavalini designed a seed drill during the late sixteenth century that he claimed would use only half the grain and still yield one-third more crop than if broadcasting were used, but there is no evidence that such a machine was ever made. Other inventors, most not farmers themselves, also designed seed drills. Alexander Hamilton, Daniel Ramsay, and Gabriel Plattes obtained patents for their seed drills, but only Plattes left a record of what the machine would have looked like. Later, John Worlidge designed a seed drill, but it was not actually made and used until much later. In fact, though Tull initially claimed that his invention was not dependent on any earlier accounts of seed drills, he later acknowledged that he had seen drafts of John Worlidge's drill. Tull, however, was the first person to construct a seed drill that worked.

A country gentleman of means, Tull was Oxford educated and later was admitted to the bar in 1699, but instead of practicing law, he left London for his father's farm at Howberry, Crowmarsh, where he conducted his agricultural experiments. He was one of several agronomists who worked on what was then called the Norfolk System. Tull did not like the wasteful broadcasting method of sowing seeds, but his workers were tied to the traditional broadcasting technique. Tull wanted his workers to make channels, sow smaller quantities of seed, and then cover the seeds with soil. In his absence, his workers turned to broadcasting, so around 1701, Tull designed and made his seed drill.

The drill, which was later described and illustrated in Tull's *The New Horse Houghing Husbandry: Or, An Essay on the Principles of Tillage and Vegetation* (1731), was horse drawn and consisted of three narrow hoes, which allowed for the seeding of three rows at a time. The hoes had passages behind them that guided the seed from the funnels



Jethro Tull's seed drill. (Hulton Archive/Getty Images)

above to the channels in the ground. The hoes, the framework supporting them, and the shafts resting on the ground were carried by the four wheels of the machine. The large front wheels carried the seed box and the dropper unit that fed the center hoe, and the two smaller rear wheels carried the droppers and seed boxes feeding the other two hoes. The dropper unit consisted of the case at the bottom of the seed box and the notched axle that passed through it. The axle with notches and cavities turned the wheels, took on the grain from the boxes above, and dropped it into the funnels that went behind the hoes. The passage of grain past the notched dropper had a brass cover and an adjustable spring similar to the tongue in an organ. (Tull had earlier taken apart an organ and noticed its rotating cylinder.)

Tull's machine initially had limited success. Tull did succeed in growing wheat on the same field for thirteen successive years without having to let the field lie fallow (that is, allow the field to "rest" between crops to build up depleted soil nutrients). He never had the chance to use the seed drill for the planting of sainfoin, a kind of legume that was Tull's favorite crop. Tull's seed drill was not widely adopted after he demonstrated its viability. The drill had its detractors, and there was considerable controversy about its usefulness.

In 1709, as a result of some pulmonary problems (he was often sick), Tull toured Europe, hoping to recover his health. He observed seeding practices, particularly in France and Germany, and incorporated European approaches into his own thinking. In 1731, his *The New Horse Houghing Husbandry* helped spread his ideas.

Also in 1709, Tull moved from Crowmarsh to Prosperous Farm, at Hungerford, Berkshire, where he continued to work on agricultural machines. In addition to the seed drill, he invented a horse hoe and a four-hoed plow. His was a holistic approach to farming, but few farmers actually adopted all of his ideas, particularly his belief that hoeing the soil made the use of manure unnecessary.

After his death in 1741, the controversy over Tull's ideas abated, but following Henri-Louis Duhamel du Monceau's *Traité de la culture des terres suivant les principes de M. Tull anglais* (1753-1761; *A Practical Treatise of Husbandry*, 1759, 1762), a six-volume "extract" of Tull's ideas, and John Mills's translation of the French book into English, the debate renewed. Despite some critics, this time Tull's ideas, perhaps because of Monceau's book, carried the day. There were, however, still some farmers and many field hands who clung tenaciously to the past and who were suspicious of "new" ideas. Tull had argued that his drill and his agricultural methods were financially advantageous, but he did not have the financial accounts to support his claims. Ultimately, the battle was won on the agricultural fields.

SIGNIFICANCE

Scholars specializing in agricultural machinery claim that all subsequent seeding machines were derivative copies or were heavily influenced by Jethro Tull's designs. His theories were widely promulgated, especially in France, where his works were translated by Monceau. Despite the fact that his seed drill worked, it was not until the nineteenth century that it was manufactured on a large scale. His methods were even more effective after 1830, when the subsoil plow broke up deeper levels of the soil, aerating it, and by 1866 a modification of his seed drill was a common implement on every farm in England. According to G. E. Fussell, a leading historian of farm machinery, Jethro Tull's first seed drill with its internal moving parts was the precursor of complex twentieth century agricultural machines.

Though some of his theories are still debated, his invention of the seed drill remains one of the most important agricultural advances of all time.

Thomas L. Erskine

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■ 1747

MARGGRAF EXTRACTS SUGAR FROM BEETS

At a time when Europe was dependent on expensive sugar from sugarcane grown using slave labor in the Caribbean, Andreas Marggraf discovered that sugar extracted from a European crop, the beet, was identical to that from sugarcane. His discovery eventually led to the development of a commercially successful sugar beet industry in Europe and North America.

LOCALE: Berlin, Prussia (now in Germany)

AGRICULTURAL ISSUES: Botany; Chemistry; Food processing; Innovations; Scientific research; Slavery

KEY FIGURES

Andreas Sigismund Marggraf (1709-1782), German chemist

Franz Karl Achard (1753-1821), German chemist and a student of Marggraf

Napoleon I (Napoleon Bonaparte; 1769-1821), military leader and emperor of France, r. 1804-1814, 1815

Benjamin Delessert (1773-1847), French industrialist

SUMMARY OF EVENT

Prior to the development of the sugar beet industry, the world's supply of refined sugar was extracted entirely from a grass called sugarcane (*Saccharum officinarum*). Sugarcane is an old crop, believed to have been harvested for the first time several thousand years ago on Pacific islands. During the Middle Ages, it was widely grown in the Mediterranean region. Nevertheless, honey long remained the major sweetener in Europe, because cane sugar was prohibitively expensive. Then, in the seventeenth and eighteenth centuries, sugarcane grown on Caribbean islands, first by the Spanish and Portuguese and later by the British and French, became the world's chief source of sugar and a major commodity in world trade.

To provide for the highly labor-intensive cultivation and processing of sugarcane, Europeans transported large numbers of slaves

across the Atlantic from Africa. As larger quantities of sugar reached Europe, the price declined, and Europeans increasingly developed a “sweet tooth,” though the substance remained a luxury.

In contrast to that of cane sugar, production of sugar from beets (*Beta vulgaris* in the family *Chenopodiaceae*) got off to a slow start. During the late sixteenth century, a French agronomist, Olivier de Serres, noted that beet roots that had been cooked produced a juice similar to sugar syrup. It took another 150 years, and the work of Andreas Sigismund Marggraf, to isolate and identify sugar in beet roots, and another fifty years before commercial sugar beet production got under way.

Beets come in a number of varieties, including the common garden beet, whose leaves and roots have been eaten as vegetables since ancient times. Another variety of beet has long been used as livestock fodder. The roots of sugar beets are white and sharply tapered, and commonly grow to a depth of six feet. Although they are biennial plants, they are commonly harvested at the end of their first growing season. All beet varieties are descendants of a wild beet plant that still grows on the European seacoast.

Marggraf, whose achievements include a number of refinements in the analytical tools of chemistry, was an expert at “wet methods,” or solvent extraction, and at carefully washing and recrystallizing the end product of such extraction. In 1747, he used hot alcohol to extract the juices from several crop plants commonly grown in Europe, including the root of a beet variety used for livestock fodder. After the extraction, minute crystals appeared in the beet root’s dried juice. Using a microscope, Marggraf recognized that these crystals were identical to the crystals produced by sugarcane. The sugar in both beets and cane is now known to be sucrose. Marggraf’s achievement may have marked the first time a microscope was used for chemical identification.

Although Marggraf had identified beet extraction as a potential means of producing sugar in Europe, his initial extraction process was expensive—unsurprisingly, since it was invented as a method of scientific research rather than industrial production. In an effort to provide poor European farmers with a means of producing their own sugar, Marggraf later developed a less expensive method, in which beet roots were macerated to obtain the juice and a calcium hydroxide solution was used to help crystallize the sugar. His vision of a cheap,

new source of sugar for the farmer did not materialize, however, and its discovery remained a mere laboratory curiosity for half a century.

The commercial potential of beet sugar was clear, though. A new source of sugar would find a ready market, because sugar was still a luxury item despite declines in price due to the burgeoning supply from the Caribbean. Furthermore, unlike sugarcane, which was a tropical crop, beets were adapted to temperate climates such as those in Europe, so they could be grown in the regions where large amounts of sugar were consumed. In addition, with antislavery sentiment on the rise in some quarters of European society, there was growing unhappiness with the slave-based Caribbean sugar industry.

In 1786, four years after Marggraf's death, the king of Prussia became interested in the commercial potential of beet sugar. A subsequent Prussian king granted Franz Karl Achard, a student of Marggraf, an estate in Silesia, where Achard began artificial selection of beets as a source of sugar. In addition, Achard built the first pilot beet-sugar refinery, at Cunern, Silesia (now in Poland), in 1802. This factory, however, was not profitable.



Early twentieth century Colorado farmer loading sugar beets onto a truck. (Library of Congress)

SIGNIFICANCE

Marggraf's discovery of sugar in beet roots led to the development of an industry that rivaled the sugarcane industry. More than any other crop plant, the modern sugar beet is an industrial crop plant developed by human efforts in plant breeding. It is tailored for processing in centralized factories. Beets have been bred, for example, to have sugar contents as high as 20 percent, compared with the original 2 percent.

The eventual rise of a successful sugar beet industry owes much to French emperor Napoleon I, who became interested in developing such an industry after the British navy cut off his empire's supply of cane sugar from the Caribbean. Napoleon financed beet research, cultivation, and factories, in the hope that sugar beets would provide a domestic source of sugar for his armies. Benjamin Delessert in 1812 became the first person to extract beet sugar in large quantities. Two years later, forty small factories had opened in France, Belgium, Germany, and Austria.

Many people were suspicious of beet sugar, however, and after Napoleon's empire fell in 1814, the French sugar beet industry collapsed, as the country eagerly returned to importing cane sugar. Even so, the French achievements in sugar beet technology were not forgotten, since sugar beets offered a source of sugar that could be cultivated domestically in quantities large enough to preclude the need for costly imports from across the Atlantic. Production subsequently increased rapidly throughout Europe. At the end of the nineteenth century, sugar beets were also being grown in North America, and beets surpassed sugarcane as a source of world sugar.

A major factor in the commercial success of sugar beets is their adaptation to temperate and cold climates. With advances in beet breeding and technology, sugar beets became an attractive crop for Europeans to grow. The success of the crop contributed significantly to the decline of the slave-based system of cane sugar production in the Caribbean, which had fueled much of Western commerce in the seventeenth and eighteenth centuries.

Sugar beets, which are by far the most important commercially grown beets, have become an important crop in many parts of the United States and southern Canada, and they are even more important in other parts of the world. The major sugar beet growing areas

are countries of the former Soviet Union as well as France, Germany, the United States, Poland, and Turkey. In the United States, the states of California, Minnesota, Idaho, North Dakota, and Michigan are major growers of the sugar beet. As of the early twenty-first century, sugar beets provided close to 40 percent of the world's supply of sugar.

Jane F. Hill

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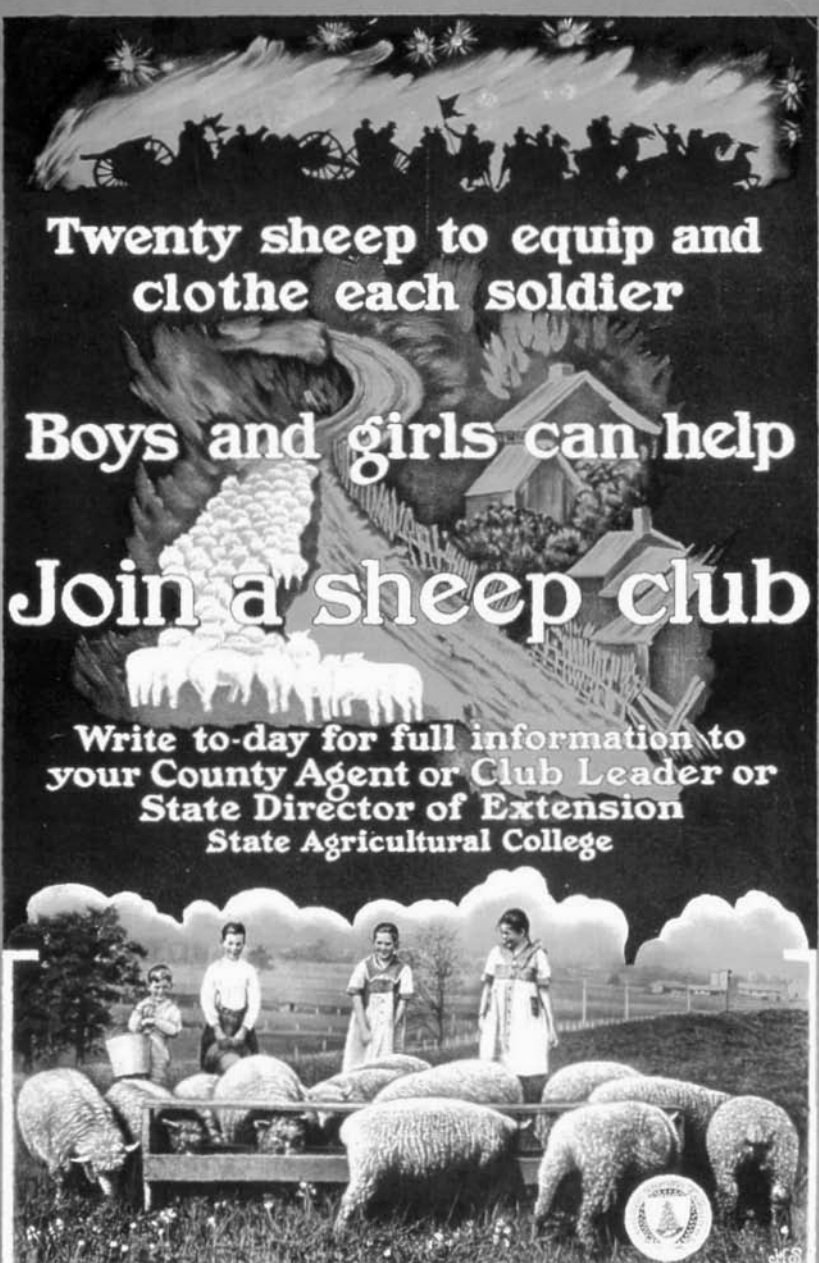
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MAGILL'S CHOICE

AGRICULTURE IN HISTORY

Volume 2

1753-1958

from

The Editors of Salem Press

R. Kent Rasmussen

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■ 1753

LIND DISCOVERS THAT CITRUS FRUITS CURE SCURVY

Building upon previous medical accounts and motivated by the medical disasters of long sea voyages, James Lind proved that citrus fruits can prevent and cure scurvy. His results, published in 1753, helped to convince the British court to order the rationing of citrus juice to all sailors, thus dramatically reducing scurvy in the Royal Navy.

LOCALE: Scotland; England

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Disease and health issues; Scientific research

KEY FIGURES

James Lind (1716-1794), a Scottish naval surgeon and physician

Aleixo de Abreu (1568-1630), a Portuguese physician specializing in tropical medicine

Lord Anson (1697-1762), an English admiral

Sir Gilbert Blane (First Baronet Blane; 1749-1834), a Scottish physician

James Cook (1728-1779), an English naval officer and explorer

Sir John Pringle (First Baronet Pringle; 1707-1782), a Scottish military physician

Boudewijn Ronsse (1525-1597), a Flemish physician

Thomas Trotter (1760-1832), a Scottish naval surgeon and physician

John Woodall (1570-1643), an English surgeon, physician, and chemist

SUMMARY OF EVENT

Scurvy is a deficiency disease caused by lack of ascorbic acid (vitamin C) in the diet. The word “ascorbic,” coined in 1933, derives from the Greek prefix *a*, meaning “not,” and the Latin *scorbutus*, meaning “scurvy.” Ascorbic acid is necessary for the body to produce collagen, an essential structural protein. Without sufficient collagen, capillaries break down, causing the typical symptoms of scurvy, such as spongy gums, anemia, general weakness, spontaneous bleeding, muscle pain, and sometimes ulcers, tooth loss, and dementia. Sud-

den death from hemorrhaging may occur at any time. In children the disease interferes with growth. Symptoms appear between one and three months after the last intake of ascorbic acid. Replenishing ascorbic acid to physiologically acceptable levels by consuming citrus products usually cures scurvy, as the acid restores collagen.

Scurvy, especially common among sailors until the end of the eighteenth century, was a major problem for merchant, naval, and whaling fleets. Naval surgeon James Lind's *A Treatise of the Scurvy* (1753) demonstrated empirically that the preserved juices of citrus fruits, such as lemons and limes, could prevent and cure this disease, which was dreaded among sailors on long voyages. However, Lind was not solely responsible for the conquest of scurvy. The disease came to be understood over a period of about four hundred years, from the sixteenth to the twentieth century. Citrus "therapy" was known before Lind but was not widely recognized or implemented even after his book appeared. Almost half a century passed before his recommendations were put into common maritime practice.

In 1564, Flemish physician Boudewijn Ronsse explained how sailors from northern Europe would cure themselves of scurvy by eating citrus fruits as soon as they reached Spain. English physician John Woodall, in his classic 1617 work on naval hygiene and surgery, *The Surgions Mate*, specifically mentioned limes, lemons, and oranges as cures for scurvy. In 1623, Portuguese physician Aleixo de Abreu described the use of a wide variety of natural food remedies, some of which contained ascorbic acid. John Pringle laid the foundations of modern military and naval medicine and hygiene with his *Observations on the Diseases of the Army* (1752) and *A Discourse upon Some Late Improvements of the Means for Preserving the Health of Mariners* (1776).

England and Spain were enemies between 1739 and 1748, the years occupied by the War of Jenkins's Ear and the War of the Austrian Succession. In this context, Lord Anson commanded a British fleet of six ships—the *Centurion*, *Gloucester*, *Severn*, *Pearl*, *Wager*, and *Tryal*—that circumnavigated the globe and plundered more than £400,000 of Spanish treasure between 1740 and 1744. Anson returned home a hero. Both he and the treasure were paraded through the streets. However, the strategic and political success of his mission was overshadowed by the fact that only the *Centurion* and about two hundred sailors returned with him. More than 80 percent of the

fleet's crew had died of scurvy, so the voyage was widely regarded as a tragedy.

Reacting to Anson's misfortune and inspired by Woodall, Lind resolved to find an answer to the scurvy problem. In 1747, he performed one of the first controlled clinical trials in the history of medicine. Aboard the *Salisbury*, where scurvy had appeared after about a month at sea, Lind chose twelve sailors suffering from early and similar stages of the disease, divided them into six pairs, and rationed each pair a different traditional remedy for scurvy. After six days of this treatment, only the pair that received two oranges and one lemon a day showed noteworthy improvement. The pair who drank apple cider improved slightly. None of the other four pairs improved at all.

Lind published the results of his clinical trial in his 1753 treatise, which he dedicated to Anson, and followed this work with *An Essay on the Most Effectual Means of Preserving the Health of Seamen in the Royal Navy* (1757) and *An Essay on Diseases Incidental to Europeans in Hot Climates with the Method of Preventing Their Fatal Consequences* (1768). He recommended preserving citrus juice in alcohol for use on long voyages. Despite the conclusiveness of Lind's reasoning and the success of the *Salisbury* experiment, few sea captains took notice. Momentum for policy change slowly gathered, however.

Using Lind's recommendations, Captain James Cook lost only one sailor to scurvy during his second exploratory voyage from 1768 to 1771. Pringle included Cook's report in his 1776 work. Gilbert Blane commented favorably on Lind's method and his own replication of citrus therapy in *Observations on the Diseases Incidental to Seamen* (1785). Nevertheless, even after these events and testimonies, the highest officers of the Admiralty (Royal Navy board) remained unconvinced. On the skeptical side was naval surgeon and physician Thomas Trotter, whose *Observations on the Scurvy* (1786) proclaimed frankly that Lind's work, even the *Salisbury* experiment, had not settled the questions of what causes scurvy or what to do about it.

Blane persisted in trying to achieve official recognition of citrus therapy for scurvy in the Royal Navy. From his prestigious posts as physician to the prince of Wales, attending physician at St. Thomas's Hospital, fellow of the Royal Society, and member of the Admiralty Board for Sick and Wounded Seamen, he lobbied vigorously for re-

form, recalling his own experience as ship's doctor in the American Revolutionary War when a captured cargo of limes had saved the crew from scurvy. The Admiralty was finally impressed by a nineteen-week voyage from England to Madras in 1793. The crew received regular rations of lemon juice preserved in alcohol and were entirely free of scurvy. In 1795, the Admiralty issued the order that all British naval ships must issue citrus juice to every crew member every day. By 1797, scurvy had practically disappeared from the Royal Navy.

SIGNIFICANCE

Both James Lind and Gilbert Blane were largely responsible for the dominance of British naval power until the end of the age of sail. The combination of the best ships in the world plus healthier crews proved unbeatable. In the nineteenth century, British sailors and, soon, all Britons, especially Englishmen, became known as limeys, after "limes," because of Blane's strict regulations on diet.

The final steps in conquering scurvy occurred in the twentieth century. Hungarian-born biochemist Albert von Nagrapolt Szent-Györgyi discovered ascorbic acid in 1927-1928, isolating it from the adrenal glands. He subsequently found the same compound in paprika after noticing that paprika is a remedy for scurvy. In 1933,

West Indians harvesting limes during the early twentieth century. During the nineteenth century, Great Britain's Royal Navy was so well known for feeding citrus juices to sailors to prevent scurvy that British sailors were nicknamed "limeys" by Americans and Canadians.
(Library of Congress)



Leonard Parsons reported successful treatment of infantile scurvy with ascorbic acid. Since that time scurvy has existed only in mild cases in isolated populations with poor mixes of fruits and vegetables in their diet.

Eric v. d. Luft

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■ 1760's

BAKEWELL INTRODUCES SELECTIVE LIVESTOCK BREEDING

Robert Bakewell, one of the most prominent of the agricultural breeders of the eighteenth century, revolutionized cattle and sheep breeding by using scientific methods to develop new breeds designed to maximize meat production.

LOCALE: England

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Draft animals; Innovations; Scientific research

KEY FIGURE

Robert Bakewell (1725-1795), a British tenant farmer and animal breeder

SUMMARY OF EVENT

Livestock breeding in England at the beginning of the eighteenth century was haphazard at best. In many cases breeders simply relied on chance matings among a group of animals kept in a common enclosure. Offspring with desired traits would be kept, and the others would be sold for slaughter. The predominant principle was to “outbreed.” Inbreeding, or mating between those closely related, was believed to weaken the offspring and ruin the breed. Where purposeful breeding was practiced, hybridization between different lines or breeds was the rule.

The prevailing practices resulted in a confusion of breeds, many of them local, which tended to have variable characteristics. The variability was actually maintained, if not increased, by the very practices in vogue. This led to difficulty in clearly defining breeds, as such, and largely explains why few of the breeds from this era still exist.

Although there were a few other eighteenth century breeders who made impacts on livestock breeding practices, none was as prominent as Robert Bakewell. He made his mark by a combination of innate skill, careful breeding practices, and the discarding of prevailing breeding practices. Bakewell was born into a long-standing family of

tenant farmers in Dishley, Leicestershire. As a young man he traveled throughout Europe observing farming practices and livestock breeding typical of each region. When he settled back at Dishley, he apprenticed under his father, eventually inheriting the farm when his father died in 1760. It was his thorough training and methodical nature that led to his eventual success, more as a breeder than as an entrepreneur.

Bakewell's greatest innovation was to breed his animals "in-and-in." This method involved not just incidental inbreeding, but carefully planned and extensive inbreeding. Bakewell traveled all over England, and even sometimes continental Europe, in search of animals with the traits he wanted to improve upon. When he obtained animals with the right combination of traits, he would have the animals mate. Their offspring would then be carefully evaluated for improvement in the chosen traits, and those with the best match would then be bred with either a sibling or a half sibling, or even backcrossed with a parent. Bakewell would have animals that were a little more distantly related mate to counteract some of the negative impacts of inbreeding. Key to his success was keeping males and females in separate enclosures, allowing only the mixing of those males and females that were to mate.

When Bakewell first began his breeding experiments, he was met with almost universal ridicule by other farmers. Predictions were that he would weaken his herds and end up with worthless animals. Although the in-and-in approach often did lead to weaker, lower-birth-weight offspring, as well as a somewhat higher rate of birth defects, his persistence paid off with improvements in the traits he sought and the development of stable, valuable breeds. His success eventually led to wide acclaim.

Bakewell developed new breeds of cattle, sheep, horses, and pigs, but his most enduring work was with cattle and, especially, sheep. His goal for cattle and sheep was to produce animals that maximized high-fat meat production in the shortest time possible. Because the common laboring class in England worked long hours at manual labor, meat high in fat, and therefore high in calories, was preferred. Rapid growth and fattening on minimal feed was also desired because it translated into cost savings for the farmer.

By twenty-first century standards, the improved longhorn, or



Sheep station in early twentieth century Australia, a continent more than half of which is pasture land ideal for breeding livestock. (Library of Congress)

Leicester, bull, with its high fat content, would be a disaster for consumers and farmers alike. However, Bakewell developed this breed to meet the culinary needs and preferences of his day, rather than of the modern taste for lean beef. His goal was to develop a bull with high fat content and reduced bone diameter that could fatten adequately for butchering within a few years on a minimal amount of feed. When choosing animals to begin this process, Bakewell relied not just on his eyes; he also handled the animals extensively, evaluating bone structure and fat distribution. Some of his contemporaries considered him to have an innate sense that allowed him to select just the right animals.

Choosing the animals was only the start. He also kept extensive records on each animal for each of the traits he was attempting to improve. He also carefully monitored weight gain and the amount of feed used by each animal. His observations did not stop once the animal was butchered. He would carefully study the flesh, analyzing it

for fat content and texture, and would measure bone diameter. From particularly fine specimens he sometimes preserved in alcohol portions of the animal, such as a leg joint, for later study.

Although Leicester cattle have been nearly forgotten, the Dishley, or Leicester, sheep are ancestors to many successful modern-day sheep breeds found from North America and South America to Australia and New Zealand. Bakewell's goals in producing the Dishley breed of sheep were similar to those he had for longhorn cattle—rapid production of high-fat-content meat with minimal feed—but he did not completely ignore wool characteristics. Mutton, although eaten, was typically from sheep who were past their prime for producing wool. The Dishley was the first major sheep breed designed more specifically to be meat producers.

A more technical innovation developed by Bakewell was the progeny test. Determining which bulls or rams will be the best sires can take a long time, unless they can be mated with many different females. The proof of a good sire is its consistent production of offspring with stable, superior breed traits. Although Bakewell kept a large number of his own animals, there still were not enough of them to progeny-test his bulls adequately. This led to the establishment of the Dishley Society.

The Dishley Society was composed of Bakewell and other serious animal breeders in the areas around Dishley. By banding together and sharing information, they could hasten the development of quality breeding stock. Loaning bulls and rams for breeding service was a central activity. The more offspring a given animal sired, the more data could be accumulated about their breeding potential. Thus, within a few seasons, the best sires could be identified and properly exploited for maintaining the breed.

To ensure success and to prevent loss to members the Dishley Society developed an elaborate set of principles that all members had to follow. For example, principle six states, "No member shall let a ram to anyone who lets or sells his rams at fairs or markets." The principles, for the most part, helped establish and maintain the society as a monopoly on the members' breeds. Violating any of the principles resulted in fines, and in more serious cases, expulsion from the society.

The Dishley Society also stipulated prices to be charged for letting

rams and bulls. Some of Bakewell's best sires commanded what some considered to be exorbitant letting prices, but these higher rates attest to the quality of Bakewell's breeding stock. By the latter part of the eighteenth century, most other British livestock breeders were using Bakewell's methods. With time his practices became standard procedure, being much the same into the twenty-first century in basic principle.

SIGNIFICANCE

Bakewell was applying principles consistent with a more modern genetic approach, even though the genetic discoveries of Gregor Mendel were made decades later, and their acceptance came more than a century later. Bakewell's innovation of breeding in-and-in started a revolution in livestock breeding that paralleled the Industrial Revolution and helped provide food for the newly expanded working class. His scientific methods enabled him to see beyond the unsupported beliefs of other breeders that, for example, inbreeding was detrimental.

Bryan D. Ness

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■ 1763-1767

ANTIQUATED FARMING BRINGS FAMINE TO SOUTHERN ITALY

During the mid-1760's, food shortages, intensified by insufficient harvests, feudalistic practices, and flawed food distribution systems, resulted in famine conditions, which prompted rural populations to migrate to urban areas. Because charities and governments failed to provide sufficient relief, some famine victims rioted. Several hundred thousand people died either from starvation or from diseases exacerbated by unsanitary conditions.

LOCALE: Kingdom of Naples; Tuscany; Papal States; Rome

AGRICULTURAL ISSUES: Disease and health issues; Famine and hunger; Feudalistic systems

KEY FIGURES

Bernardo Tanucci (1698-1793), regent of Naples, r. 1759-1767, and secretary of state, 1768-1776

Ferdinand IV (1751-1825), king of Naples, r. 1759-1806, and king of the Two Sicilies as Ferdinand I, r. 1816-1825

William Hamilton (1730-1803), English ambassador to the court of Naples, 1764-1800

Antonio Genovesi (1712-1769), Italian economist

Cesare Beccaria (1738-1794), Italian author

Pietro Verri (1728-1797), Italian publisher and writer

Alessandro Verri (1741-1816), Italian writer and editor

SUMMARY OF EVENT

In 1759, the southern Italian peninsula experienced low food supplies but survived due to aid from Sicily and the Middle East. Many people living in Naples, Tuscany, and the Papal States began experiencing famine several years later, when poor harvests resulted in demand overwhelming supplies, and food storage centers (*annona*) inefficiently gathered and distributed foodstuffs.

Agricultural conditions and methods in the southern Italian kingdoms and principalities were inferior to and differed from northern



Tuscan farm. (©Robert Paul Van Beets/Dreamstime.com)

practices. Much of the south practiced feudalism: The elites—the nobility and ecclesiastical leaders—owned the majority of land, which peasants farmed. That system discouraged the use of improved implements and varied plants, which could have increased yields and replenished exhausted fields. For the most part, southern landowners, both secular and religious, were apathetic about bettering farming techniques, a course many agriculturists in Europe and northern Italy were pursuing. Wealthy landowners often lived in cities and rarely involved themselves in agricultural matters. Foreign demands controlled much of the southern Italian agricultural trade: Peasants were forced to grow olives, grapes, and inedible fiber crops, rather than grain, to sell to international markets and manufacturers in exchange for luxury goods not available in southern Italy.

Extreme winter and spring weather over a period of several years proved detrimental to most harvests during the mid-1760's. Prices rose drastically, and many people could not afford to buy such basic nutritional items as bread. By 1763, southern Italy was experiencing a famine. The famine most severely affected already impoverished people. The wealthy could purchase available food.

Ferdinand IV, the third son of Spain's Charles III, had become king of Naples in 1759, at the age of eight. The government was effectively in the control of Ferdinand's regent, Bernardo Tanucci, who had previously dealt with food shortages by seeking external aid and relying on long-established internal charities. Tanucci stated in April, 1764, that European governments lacked sufficient food reserves to feed hungry Neapolitans, noting that a weak economy had strained all of Europe. Piedmont sent some emergency aid but not enough to sustain the entire kingdom. Few Mediterranean relief shipments arrived at Naples's port.

The famine in the Kingdom of Naples was especially severe in Campania and Capitanata provinces. Because the city of Naples historically had distributed food through its *annona* and charities, many rural people swarmed that city seeking relief. The government failed to provide sufficient food, however, and most charities were unable to respond adequately to people's needs. Selfish behavior worsened relief work. The wealthy and powerful felt entitled to receive aid first and hoarded food. Some local *annona* administrators corruptly mismanaged their supplies. In contrast, St. Paul of the Cross asked monks to give half their rations to hungry people.

Although some famine victims responded to the food shortages with open aggression, few people rioted in Naples. Most people believed God had caused the famine to punish sinners. They did not perceive the government and charitable institutions as being responsible for causing, intensifying, or prolonging the famine. Despite relatively peaceful conditions in Naples, however, agitated people did revolt in other cities, including Crotone, Altamura, and Rossone. In some rural communities, lawlessness prevailed, and villagers assaulted their feudal lords, occasionally destroying castles.

People from the state around Rome began migrating into that city in 1764, seeking nourishment and assistance. The Roman troops managed the resulting crowds, preventing irate mobs from engaging in hostilities. Gathering relief food supplies in centralized locations, the Roman *annona* and Florentine *abbondanza* provided victims with more consistent sources of foodstuffs and financial aid than their counterparts in Naples. French relief arrived by ship at the ports of Livorno and Civitavecchia.

In December, 1764, English ambassador William Hamilton com-

mented that the bitter winter weather was contributing to the suffering of famine victims. He saw approximately two thousand patients, wearing threadbare clothing, squeezed into an overwhelmed Naples hospital. Hamilton watched starving people begging because charities' bread supplies were depleted. Epidemics, including typhus, struck large populations. Disease spread as people migrated from rural to urban areas. Poor nutrition and vitamin and protein deficiencies weakened immune systems. Deprived of grain, some people ate weeds. Famine victims obtained limited food dispersed at festivals, including the 1764 *carnevale* at Naples.

The southern Italian famine lasted through 1767 in some places and accounted for at least 300,000 deaths due to starvation or disease. Children and the elderly represented many of the losses. The Kingdom of Naples suffered the most. Casualties in the city of Naples alone totaled 40,000 people, and the kingdom lost an estimated 200,000 people. Rome, the Papal States, and Tuscany suffered fewer losses. Reduced production and loss of agricultural laborers during the famine years further devastated southern Italy's economy. European nations sought alternative trading partners. Urban-rural conflicts divided much of the population and slowed efforts to restore the countryside. The famine upset social order and revealed deficiencies in government, altruistic organizations, and agricultural practices.

SIGNIFICANCE

Some intellectuals had demanded governmental and social reforms prior to the famine. The catastrophe intensified reform efforts, because people realized the shortcomings of social institutions, both governmental and charitable, to relieve misery and their inability to deal adequately with famine conditions. Landowning nobles opposed reforms, and most government officials were unwilling to admit the extent to which their policies benefiting the privileged had enabled the famine to happen. Influenced by Enlightenment ideas, intellectuals, especially Antonio Genovesi and Cesare Beccaria, debated how to revise southern Italian policies, counter traditions that stagnated southern Italian provinces, and encourage different ways to perceive social concerns.

Pietro and Alessandro Verri published *Il Café* during the famine

years, urging elites to reform agriculture and commerce. Publications targeting landowners explained how to achieve better agriculture by managing land, draining excess water, terracing slopes, and utilizing technology. Low literacy rates prevented many peasants from benefiting from such advice. Reformers targeted guilds for hindering agricultural trade. They also criticized charities, confraternities, and clerics who blocked land reforms and refused to act philanthropically to the poor. Although most reforms were unfulfilled, some *annone* and local schools and organizations improved.

The famine initiated discussion of free trade of food, especially grain. Governments controlled grain distribution, and laws forbade free trade. Although Italian leaders in the north accepted free trade, officials in Tuscany delayed permitting free trade until 1775, and leaders in Naples retained tariffs and controls to protect trade until the 1780's, when some restrictions were ended. Seeking to alter unproductive landholding practices, reform-minded officials criticized feudalism and promoted land ownership among commoners. Twenty years after the famine, the government of Naples secured jurisdiction over numerous rural villages. The famine contributed to Neapolitans' distrust of their leaders. In 1799, when France conquered the kingdom and instituted the short-lived Parthenopean Republic in its place, many peasants supported the new republic against Ferdinand.

The famine was a catalyst for some reform attempts and challenging the governmental and societal status quo, but most governments were uninterested in immediately improving land and charity policies. Italian reform efforts during the famine influenced reformers in other countries, contributing to the increased scrutiny of feudalism in Scotland and elsewhere. After the famine, some agriculturists individually initiated reforms, seeking fertile land at previously ignored higher altitudes to plant corn and other edible crops. Official reforms did not occur until later in the century. Gradually, in famine-stricken areas, leaders approved land reforms, including some field enclosures, encouragement of crop rotation, and limitations on the feudal system. Agricultural changes and political reforms spared southern Italy the subsequent severe food shortages that affected Europe, particularly the 1840's Irish famine that killed one million people.

Elizabeth D. Schafer

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■ APRIL 27-MAY, 1775

FRENCH PRICE CONTROLS AND POOR HARVESTS PROVOKE FLOUR WAR

Riots swept the provinces surrounding Paris, caused by the lifting of government controls over the price of grain following the poor wheat harvest of 1774. Ultimately, two French armies quelled the riots. However, the event was indicative of the poverty and poor economic management that would bring about the French Revolution at the end of the following decade.

LOCALE: Paris, France, and its rural environs

AGRICULTURAL ISSUES: Government policy and regulation; Marketing and trade; Price supports and controls

KEY FIGURES

Anne-Robert-Jacques Turgot (1727-1781), controller-general of France, 1774-1776

Louis XVI (1754-1793), king of France, r. 1774-1792

Louis XV (1710-1774), king of France, r. 1715-1774

Jacques Necker (1732-1804), French director-general of finances, 1777-1781

SUMMARY OF EVENT

Bread was the staff of life in early modern Europe. In 1775, a typical French laboring family of four ate 1.2 tons of grain per year, 80 percent of which came from the Paris basin, a rural area extending to a ninety-mile radius around the city. Town workers in France normally spent half their salary for the purchase of bread. While wages for most common laborers were structured to support their basic subsistence, periodic steep rises in the price of grain caused by poor harvests often meant death for family members, particularly in towns and cities. Eighteenth century France was in the midst of urbanization and rapid population growth, leaving it vulnerable to periodic starvation. There was no corresponding growth in new land under cultivation or improved agricultural techniques to increase productivity. Yet with only five exceptions, harvests in France were good prior to 1774.



France's King Louis XVI.
(Library of Congress)

Royal price control of grain was an integral part of mercantilist economic policies, and France's absolutist monarchy was Europe's leading mercantilist power. Hence, in times of scarcity the people looked to the monarchy for protection. French aristocrats too welcomed stable grain prices, because they led to social stability and protection of their privileged position in society. When the government was slow to respond, local grain riots did occur, but these were sporadic and usually led to angry protesters intimidating merchants to absorb a short-term lowering of prices. Such disturbances did take place from 1763 to 1770, following a partial lifting of price controls, an act that helped to make Louis XV one of France's most detested monarchs.

With the coming to power of the twenty-year-old Louis XVI in May, 1774, expectations for reform reverberated among the population. Louis's appointment of Anne-Robert-Jacques Turgot as controller-general of France seemed to underline a commitment to promoting

economic efficiency by cutting unnecessary expenditures, reducing the nation's debt, and reestablishing its credit. One of Turgot's plans, hailed by Enlightenment writers such as Voltaire (who viewed physiocratic policies as inherently progressive), was to stimulate agricultural production by establishing free trade in grain. Unfortunately, Turgot's policy, instituted on September 13, 1774, came at exactly the wrong time, since all indices pointed to the fact that the autumn harvest would be poor. The price of grain rose steadily over the winter. By spring, 1775, when grain reserves had to be apportioned for spring planting, the cost of grain had skyrocketed.

Disturbances began on April 27, 1775, with a riot in the market town of Beaumont-sur-Oise. Rioters, consisting of common townspeople, dunked the leading grain merchant in a fountain, seized his grain, and paid about one-third of the asking price. Local authorities did not intervene. Instead of being contained, riots spread over the next three weeks to more than three hundred separate locales in the Isle de France and the four adjacent provinces. While rioters often paid what they defined as a fair price, in other instances grain was just looted in market towns. As town markets closed, crowds of rioters from diverse towns attacked grain shipments on overland routes and waterways.

Grain was seized from granaries located both in towns and in the countryside, from mills and bakeries, from rural monasteries, from stocks held in farms, and even from flour merchants' homes. Within a week of the first incident at Beaumont-sur-Oise, the royal family had to be evacuated, as mobs seized half of the grain supply of Versailles. The prince de Poix, commander of the Royal Guard, permitted the mob to set their own fair price for grain, rather than risk escalation of the rioting. The following day, more than one thousand bakeries were raided in Paris. In response, on May 4 two armies consisting of twenty-five thousand troops were ordered to restore order in town markets and the countryside, while a third army was garrisoned in Paris to restore order there. The sweeping nature of the events led to their popular appellation, the Flour War (*guerre de farines*).

Turgot's strong stand in using the army did result in suppression of the disturbances by mid-May. Of 548 rioters arrested, only 2 received the death sentence. There appear to have been no fatalities among the 447 individuals classified as having been victimized by

mob action. With his official coronation set for early September, Louis XVI was most interested in establishing order. Moreover, conditions over the late spring and summer of 1775 pointed to a bumper grain crop and a dramatic lowering of prices.

Other factors, too, argued for a policy of leniency. Many French aristocrats advocated government grain price regulation and viewed Turgot's physiocratic policies as the cause of public disorder. Moreover, rioting was directed mainly at merchants, not aristocrats, and appeared symptomatic of the immediate distress of the working poor. Women concerned about the survival of their children formed a large part of the rioting mobs. Ironically, no connection was seen at the time to any looming threat to the given social order: What the common people seemed to want were the traditional paternalistic policies of the Old Order, not new reformist free market policies, when it came to purchasing food staples. This desire was answered in 1776 by the unceremonious firing of Turgot and the reversal of free trade policies by his successor, the Swiss banker Jacob Necker.

SIGNIFICANCE

While the bread issue took backstage for more than a decade, other aspects of the French economy, such as the national debt and international credit, continued to deteriorate. By 1789, the French monarchy was threatened with bankruptcy. With the failure of the grain crop over two successive years (1788-1789), the French capital and its environs were faced with a situation even more volatile than that of 1775. Government policy again came under public scrutiny, as the price of bread rose to record heights. Grain riots began in April, 1789, and continued throughout the summer.

As is seen in the list of grievances (*cahiers*) brought by individual delegates to the Estates-General convened by Louis XVI to remedy France's economic problems, the king was held responsible for both the price and availability of bread. When the early months of the French Revolution did not resolve the grain issue, a mob of several hundred whose main core was the women of Paris marched to Versailles and demanded that Louis resolve the bread issue. The event, known as the Women's Bread March (October, 1789), resulted in the king's permanent return to Paris. Along the return route, the mob is

reported to have sung “We have the baker, the baker’s wife, and the baker’s son. Now we will have bread.”

The Flour War and the French Revolution are linked through the price and supply of bread and the potential social upheaval that can occur when people are deprived of a basic staple of life. Similar links between inflationary bread prices or bread shortages and revolution can be seen in the revolutionary storm that swept across Europe in 1848 and in the Russian Revolution of 1905. The Russian Revolution of February, 1917, which toppled czarism, also originated in bread riots which got out of control. It is no coincidence that along with “peace and land,” Vladimir Ilich Lenin promised the people of Russia “bread” if his Bolsheviks ever obtained power. This came to pass in October, 1917.

Irwin Halfond

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SEE ALSO: 1689-1694: Short Growing Seasons Create Famine in France; 1763-1767: Antiquated Farming Brings Famine to Southern Italy; May 6, 1795: Speenhamland System Aids English Farmers.

■ 1779

DISCOVERY OF PHOTOSYNTHESIS

ADVANCES PLANT SCIENCE

By studying the relationship between green plants, oxygen, carbon dioxide, and light, Ingenhousz discovered the major, externally observable structures that contribute to the process of photosynthesis. It would remain for later scientists to understand the internal chemical reactions at the heart of the process.

LOCALE: London, England

AGRICULTURAL ISSUES: Botany; Chemistry; Scientific research

KEY FIGURES

Jan Ingenhousz (1730-1799), Dutch-born English physician and chemist

Joseph Priestley (1733-1804), English clergyman and chemist

Jean Senebier (1742-1809), Swiss clergyman and naturalist

Antoine-Laurent Lavoisier (1743-1794), French chemist

SUMMARY OF EVENT

The understanding that green plants synthesize their own food is a relatively recent discovery, as is an appreciation of the importance of this process. In photosynthesis, plants use two simple, inorganic raw materials, water and carbon dioxide, and, in the presence of light, produce carbohydrate (which constitutes plant food), releasing oxygen gas as a waste product. Light provides the energy for this process. At the time of Jan Ingenhousz's discoveries, photosynthesis was only beginning to be understood.

Aristotle and other ancient Greeks had believed that plants obtain all of their nutrition from the soil, analogously to the way animals ingest their food. This belief persisted until the Enlightenment, in the seventeenth and eighteenth centuries, when intensive experimentation and discoveries led to a series of insights into photosynthesis. During the early seventeenth century, Jan van Helmont concluded from an experiment that water rather than soil was the source of the gain in dry weight by growing plants. He was correct that water played a role but incorrect in concluding that water was the sole fac-

tor. During the early eighteenth century, Stephen Hales correctly surmised that some of a plant's nutrition was derived from "air."

Ingenhousz's discoveries came later in the eighteenth century, as scientists were making great advances in the understanding of chemistry, especially the composition of air. Chemists of the time, such as Joseph Priestley and Antoine-Laurent Lavoisier, were replacing old ideas with new concepts and terminology. Their chemical dissection of the air revealed that it was composed of various gases, including carbon dioxide, oxygen, hydrogen, and nitrogen. These gases were as yet imprecisely understood, however, and they were given names such as "pure air," "dephlogisticated air," or "vital air" (oxygen) and "impure air," "vitiated air," or "fixed air" (carbon dioxide). Advances in the understanding of photosynthesis both benefited from and contributed to the growing knowledge of gases and their roles in chemical reactions.

Ingenhousz's research on plants was inspired by experiments conducted by Priestley. In 1771, Priestley had discovered that air that had been made "impure" (oxygen-poor, in modern terms) by the burning of a candle or the respiration of a mouse could be "restored" by a sprig of mint so that it was again capable of supporting combustion and respiration. By showing that animals inhale "pure air" and plants release it, Priestley had discovered the interdependence of plants

JAN INGENHOUSZ

A Dutch-English physician and plant physiologist. Ingenhousz studied medicine in the universities of Louvain, Paris, and Edinburgh and became such an expert on smallpox inoculation that he even went to Vienna to inoculate Austria's royal family. (He stayed on as court physician.) Joseph Priestley's 1771-1779 experiments on plant and animal gas exchanges under glass enclosures inspired Ingenhousz to undertake similar studies. Although Priestley found that plants can restore air exhausted by candles or small oxygen-breathing mice, he did not obtain consistent results because he did not discover that light is also essential for photosynthesis. That connection was established in Ingenhousz's *Experiments upon Vegetables* (1779), which accounted for Priestley's inconsistent results by showing that plants produce carbon dioxide at night, just as animals do.

and animals, mediated by gases. Priestley was troubled by inconsistency in his results, however.

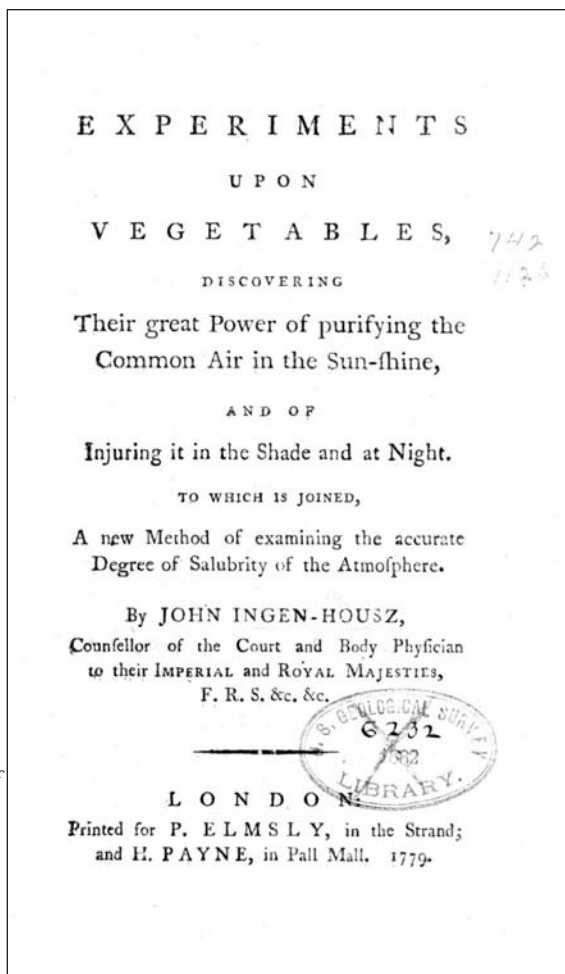
During the summer of 1779, Ingenhousz conducted more than five hundred experiments on plants. He repeated and extended the work of Priestley, performing many trials on detached leaves immersed in water. Substitution of leaves for the whole plants used by Priestley allowed Ingenhousz to draw conclusions that would have been elusive using whole plants, which are composed of both green and nongreen parts. Ingenhousz analyzed the gas composition of the bubbles that collected on the surfaces of the submerged leaves to determine whether they were “pure air” (oxygen) or “impure air” (carbon dioxide).

Ingenhousz confirmed Priestley’s observations and demonstrated, in addition, that light is required for plants to produce oxygen. Ingenhousz showed that, under brilliant illumination, plants could restore “impure air” within several hours, rather than the several days that Priestley had often found. Ingenhousz attributed Priestley’s inconsistent results to variation in the degree of illumination of Priestley’s plants from experiment to experiment. Ingenhousz also identified leaves as the portion of plants affected by light and showed that the part of the Sun’s radiation that affects them is visible light, not heat.

In addition, Ingenhousz discovered that, although the green parts of plants give off oxygen in sunlight, they emit carbon dioxide in shade and at night and that the nongreen parts of plants emit carbon dioxide in both dark and light conditions. Thus, he provided evidence that plants, like animals, perform respiration. In a modern, cellular sense, respiration is the process whereby plants, animals, and some other organisms use oxygen to break down organic compounds in order to obtain energy and molecular building blocks. In the process, they release carbon dioxide, the raw material for photosynthesis, and thus they complete what is now known as the “oxygen cycle.” Ingenhousz showed that, overall, the amount of oxygen taken up by green plants in respiration is far smaller than the amount released through photosynthesis.

Ingenhousz immediately published the results of his summer’s work in *Experiments upon Vegetables: Discovering Their Great Power of Purifying the Common Air in the Sunshine and of Injuring It in the Shade and*

*Title page of
Jan Ingenhousz's
Experiments upon
Vegetables, in which
he published his findings
on photosynthesis.
(Library of Congress)*



at Night (1779). Subsequently, Priestley claimed that he had discovered the light requirement before Ingenhousz had. Thus began a long-running quarrel between the two men over the priority of their claims. Most scholars, however, credit Ingenhousz with the breakthrough.

Working at about the same time as Ingenhousz, Swiss naturalist Jean Senebier repeated and extended Ingenhousz's experiments. Senebier showed that plants must have access to carbon dioxide in order to liberate oxygen and that the amount of oxygen liberated is related to the amount of carbon dioxide available to the plant. Using

Senebier's findings, Ingenhousz subsequently established that plants retain weight from the carbon in the carbon dioxide they absorb. Ingenhousz thereby disproved the idea that the carbon in plants is absorbed through the roots, from humus in the soil. His finding explained the disappearance of carbon dioxide during photosynthesis. He published these research results in the second of his two works on photosynthesis, *An Essay on the Food of Plants and the Renovation of Soils* (1796).

SIGNIFICANCE

Ingenhousz's work laid the groundwork for further research on photosynthesis. In 1804, Nicolas-Théodore de Saussure discovered that a growing plant gains more in dry weight than just the weight of the carbon dioxide it absorbs. He correctly reasoned—in a throwback to van Helmont—that water also contributes to the increase in dry matter of the plant during photosynthesis.

Although Ingenhousz discovered the requirement for light, he did not determine the function of light in photosynthesis. Robert Mayer, a physicist, demonstrated during the mid-nineteenth century that the amount of energy that is liberated by the combustion of the organic matter produced in photosynthesis is equivalent to the amount of light energy that the plant has absorbed. This finding showed that photosynthesis is a mechanism for converting the radiant energy of the Sun into a stored, chemical form of energy. The organic molecules produced in photosynthesis are used for energy and as building blocks for other organic molecules, both plants and the animals that eat them. The oxygen released by photosynthesis is essential to plant and animal respiration, making photosynthesis critical to life on Earth.

Late in the nineteenth century, the overall chemical equation for photosynthesis was formulated, stating that carbon dioxide and water, in the presence of light, yield glucose and oxygen. The early twentieth century brought the insight that the oxygen released in photosynthesis is derived from the splitting of water, not from carbon dioxide as Ingenhousz had thought. As of the early twenty-first century, at least fifty intermediate steps in photosynthesis had been identified, and the discovery of many more was fully anticipated.

Jane F. Hill

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■ 1779-1803

SOUTH AFRICANS FIGHT OVER FRONTIER GRAZING LANDS

Three major conflicts occurred when white settlers and indigenous peoples fought over the frontier lands northeast of the South African Cape Colony. Antagonisms had intensified since Dutch farmers first claimed Africans' territory, and war broke out when aggressive settlers and military commandos attempted to seize more land from the Xhosa and other peoples.

ALSO KNOWN AS: Kaffir Wars

LOCALE: South Africa

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; European colonization; Hunting and gathering; Land and land policy; Migration

KEY FIGURES

Joachim van Plettenberg (1739-1793), governor of the Cape Colony, 1774-1785

Adriaan van Jaarsveld (fl. late eighteenth century), Dutch commandant

Rharhabe (1722-1787), Xhosa chief, r. 1773-1787

Tshaka (d. 1793), Xhosa chief, r. 1793

Langa (fl. later eighteenth century), Xhosa chief

Ndlambe (c. 1740-1828), Rharhabe's son and Xhosa chief, r. 1787-1797

SUMMARY OF EVENT

After Dutch East India Company officials established a South African port in 1652, they encouraged some company employees to farm in frontier areas northeast of the Cape Colony. Indigenous Africans, however, relied on that territory for agricultural and hunting activities to feed their communities. The Xhosa and Khoikhoi were agriculturists. The San, sometimes called "Bushmen," were hunters. Soon after Dutch colonists began migrating to the frontier, some settlers clashed with Khoikhoi and San over territory and livestock is-



*Modern San hunter
in traditional garb.*
(©James Smit/
Dreamstime.com)

sues. Seeking more land, the colonists moved north, disregarding Africans' land claims and extending the colony's area. The Dutch settled huge farms, measuring six thousand acres. Conflicts between colonists and Africans resulted in a war from 1673 to 1677, in which European weapons overwhelmed the resisters. Deprived of farmland, many Khoikhoi worked for colonists as herders or left the frontier.

Because most frontier soils were poor, colonists concentrated on raising livestock for meat, milk, skins, and wool: Instead of growing crops, they accumulated grazing land. The Zuurveld, bordered by the Fish River, offered rich soils and grassland. During the mid-eighteenth century, Xhosa had seized the Zuurveld from the Gonaqua Khoikhoi, who had lived there, and integrated them in their communities. These African tribes encountered colonists desiring their Zuurveld land, despite Dutch company officials' attempts to set borders and their assurances that settlers were not allowed to move east of the Fish River. Those officials, however, were too far away to enforce their rules.

Colonists moved livestock across the river, perceiving most local peoples as hindering expansion. The Xhosa and colonists both valued cattle herds, which represented wealth and prestige, and needed

adequate grazing areas. Some Xhosa traded cows and indigenous products to Dutch farmers for European goods, even though the company outlawed colonists bartering directly with Xhosa.

Regarding themselves as superior, many colonists demanded that African laborers perform work with minimal compensation. Colonists sometimes prevented the laborers access to water sources. The workers responded by ruining crops and stealing livestock. Colonists complained that officials several hundred miles away did not understand the frontier situation or provide guards to prevent frontier raids. Arming themselves, groups of commandos guarded crops and herds in frontier districts and also retaliated against Africans. Commandos' weapons and horses assured them advantages over most Africans.

Upset by colonists hunting for sport on the frontier, San injured or killed the colonists' livestock and their Khoikhoi herders. They also assaulted vulnerable colonists and their families. Farmers loaded weapons for protection to perform chores. Many fled to safer places in the frontier. Unable to control San marauders, commandos requested government troops, but officials refused, demanding that colonists resolve the issue themselves. As conditions worsened by 1774, leaders appointed Godlieb Rudolph Opperman as commandant in the northern frontier. He attempted to secure a peace resolution, but military action was necessary for colonists to reclaim farms. Colonists and Khoikhoi allied to fight the San.

Relations between colonists and the Xhosa worsened as the amount of available pasture land declined and cultural misunderstandings occurred. Reports of farmers flogging African servants increased the hatred felt by the tribesmen. In 1778, Cape Colony governor Joachim van Plettenberg and several Xhosa chiefs, particularly Rharhabe, agreed that only the Xhosa could settle the Zuurveld. Hoping to prevent war with the Xhosa, van Plettenberg placed beacons to mark the boundary at the Fish River, ordering Dutch farmers to remain west of that river. Despite diplomatic efforts, however, some Xhosa moved west of the Fish River to secure land, and some colonists crossed the river to the east.

By 1779, skirmishes between the colonists and the Xhosa concerning land and water resources escalated into the First Frontier War. Some Khoikhoi fought with Dutch commandos. A 1780 policy coun-

cil emphasized the river border and approved commandos forcing Xhosa east of the Fish River. Eastern frontier field commandant Adriaan van Jaarsveld focused on that goal. He committed one of the most inflammatory acts in the war, when he threw tobacco toward a group of Xhosa and then ordered his men to shoot them when they retrieved it. The First Frontier War lasted until 1781, but distrust and resentment festered afterward.

Frontier tensions simmered for the next decade, as less land was available for everyone who wanted to live on the frontier. Xhosa chiefs, including Langa and Tshaka, brought their people and cattle into the Zuurveld, because droughts during the mid-1780's reduced available grazing areas. Also, after Rharhabe died, his successor, Ndlambe, forced many enemy Xhosa, including the Gqunukhwebe, to flee west into the Zuurveld. Colonists encountered hostile Xhosa, especially those following Langa, and they lost cattle and supplies to raiders. In 1793, militia officer Barend Lindeque and Ndlambe started the Second Frontier War when their troops ambushed a group of Xhosa who refused to abandon lands in the Zuurveld. The ambushed Xhosa fought back. Colonists fled, and Xhosa seized horses, cattle, and sheep. Commandos chased the disruptive Xhosa across the river, where Ndlambe's troops slew Tshaka and apprehended Langa.

The commandos were unable to remove targeted Xhosa, and more Africans moved into the Zuurveld. Local Dutch East India Company representatives stated that the Xhosa could retain disputed lands. Feeling betrayed that their officials had not helped them and had sided with Xhosa instead, colonists in the Graaff-Reinet frontier district revolted in 1795. They expelled the local magistrate and declared Graaff-Reinet an autonomous republic. British forces occupied the Cape Colony that year, protecting from Napoleon the port and shipping routes to India. Uninterested in acquiring additional frontier land, the British attempted to prevent wars between Europeans and Africans and dispatched forces to control colonists on the frontier.

In 1799, the Third Frontier War began after the Van Jaarsveld Rebellion in Graaff-Reinet. When van Jaarsveld was arrested for fraud, rebels rescued him. British and Khoikhoi soldiers caught the rebels, instigating chaos. Native Africans raided farms, and terrorized colo-

nists fled. Sensing an opportunity, the Xhosa and the Khoikhoi allied in an attempt to recover and secure desired frontier territory, end settler interference, and become autonomous. Colonists in the Zuurveld rebelled against the British government. During this revolt, many Khoikhoi servants stole farmers' guns and horses to use to attack and destroy colonists' property. The Africans seized an estimated fifty thousand Dutch cows and fifty thousand sheep. They razed approximately 470 farms, forcing colonists to abandon property. Reduced agricultural supplies resulted in high market prices.

Political changes affected war strategies, especially when the 1802 Treaty of Amiens returned the Cape to Dutch leadership under the Batavian administration. Realizing the frontier was crucial to the Cape's economy, Cape officials agreed to a peace treaty in 1803 that permitted both Xhosa and colonists to keep their property.

SIGNIFICANCE

After the Third Frontier War ended in 1803, the Xhosa stayed on disputed lands for almost a decade before British troops and commanders forced them east of the Fish River in 1812. The British government had resumed control of the Cape Colony from the Dutch in 1806 and pursued efforts to dominate the Xhosa. During the nineteenth century, frontier hostilities continued, with Xhosa and whites attempting to secure permanent authority. The British wanted political power to enhance their international strength. The Xhosa wanted independence to protect their homeland from foreign destruction.

Hostilities ended with the Xhosa's defeat in 1878. Conflict between white settlers and Xhosa in the frontier regions had endured with minimal interruption for more than a century, affecting trade, the economy, and culture. A total of nine Frontier Wars resulted in the Cape Colony annexing Xhosa land and peoples. Historians emphasize the significance of long-term African resistance to European interference and domination in the eighteenth and nineteenth century Frontier Wars. Sometimes referred to by Europeans as the Kaffir Wars, emphasizing their view of Africans as infidels, the Frontier Wars represented how foreign colonialism altered indigenous populations and politics, reshaping South Africa's geographical and socioeconomic boundaries. Exclusionary and racist tactics in the eighteenth

century Zuurveld lingered in divisive social and ethnic restrictions, which the indigenous people, like their ancestors, challenged.

Elizabeth D. Schafer

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SEE ALSO: c. 300 B.C.E.-c. 100 C.E.: Southern Africa's Khoikhoi and Kwadi Adopt Pastoralism; 9th-14th centuries: Southern Africa's Toutswe Kingdom Rises on Agropastoralism; 1075-c. 1220: Mapungubwe State Is Built on Cattle Culture; 1760's: Bakewell Introduces Selective Livestock Breeding; 1867: Opening of Chisholm Trail Expands Cattle Markets.

■ 1786-1787

TENMEI FAMINE DEVASTATES JAPANESE AGRICULTURE

The Tenmei era saw the most devastating famine in early modern Japan, a nationwide disaster that took as many as 130,000 lives. Many farming villages were abandoned, and large areas became depopulated. Shogunate officials provided little assistance, and they aggravated the situation through corruption and incompetence. Popular uprisings forced the officials out of office, bringing not only greater repression but also needed reforms.

LOCALE: Japan

AGRICULTURAL ISSUES: Agrarian reform; Disease and health issues; Famine and hunger; Feudalistic systems; Flooding; Government policy and regulation

KEY FIGURES

Hasegawa Heizo (1745-1795), the shogunate court official in charge of quelling unrest in 1787

Matsudaira Sadanobu (1758/1759-1829), Tokugawa Ienari's chief councilor, who carried out many needed reforms

Tanuma Okitsugu (1719-1788), the shogun's chief councillor, who was regarded by many as responsible for corruption, aggravating famine and social unrest

Tokugawa Ieharu (1736-1786), shogun, r. 1760-1786, who delegated power to Tanuma

Tokugawa Ienari (1773-1841), shogun, r. 1787-1837, initially a reformer, who was advised by Matsudaira

SUMMARY OF EVENT

The Tenmei Famine of 1786-1787, along with the Kyoho Famine of 1732 and the Tempō Famine of 1832 to 1837, were three major famines during the two and a half centuries of the Edo period. Though the Kyoho Famine of 1732 was of shorter duration, it affected close to one million people in forty-six feudal domains in Western Japan. The effects of the Kyoho Famine were mitigated, however, by active ef-

forts by the shogunate and the regional feudal lords to provide food and financial assistance to people in distress, and loans to farm communities so that they could plant new crops. Active relief efforts like these were largely neglected by the shogunate during the Tenmei Famine. This neglect prolonged the intensity and severity of hardship and famine among the people, creating disorders that undermined the power and authority of the shogunate. According to modern historians, the Tenmei Famine was the greatest nationwide disaster to occur in early modern Japan.

In 1782, persistent frost and rain led to an estimated 25 percent crop loss. This was followed in 1783 by an even more disastrous crop loss of 75 percent. There had been heavy rains and floods during the middle of June, which washed out many crops. This was followed by a huge eruption of Mount Asama in July, which killed more than twenty thousand people and produced great quantities of volcanic ash. The ash killed crops over a large area of central Honshu and blocked sunlight so that surviving crops were diminished.

In the spring of 1786, another extended spell of frost destroyed many crops in the Kanto and Tohoku regions of Honshu. More heavy rains followed, which not only ruined crops but also overwhelmed the beginnings of an ambitious Kanto drainage project planned by the shogun's chief councillor, Tanuma Okitsugu, causing large-scale flooding. The widespread famine that followed was reported to have caused severe illness and starvation, leading to the death of as many as 130,000 people.

Many of the starving wandered from place to place in search of food, resulting in a general depletion of food supplies even in communities unaffected by crop failures. The general exodus of farmworkers also resulted in local labor shortages that hindered the planting of new crops, in turn extending and compounding the famine. Many farming villages were abandoned, and people tried to survive by gathering and eating wild vegetation. There were also reported cases of the eating of corpses.

In many locations, the authorities set up shelters, where food such as rice gruel was doled out to the hungry and homeless, but the shogunate provided little substantial financial assistance to help farmers plant new crops, even in the most desperately impoverished communities. Instead, the government under Tanuma tried to set up forced



Late nineteenth century drawing of a traditional Japanese farmer fertilizing his field by hand.

(Library of Congress)

loan schemes, in which loan money would be levied from landholders and merchants and loan interest would be paid to the shogunate. Tanuma also tried to manipulate the rice market, ostensibly to keep prices down, but rice prices continued to rise as food grew scarcer. Having nowhere to turn, desperate people began to resort to violence to get food and shelter.

By late summer, 1786, the national situation had worsened to such an extent that Chief Councillor Tanuma was forced to resign, in August. Shogun Tokugawa Ieharu's untimely death followed in September, and the next six months the government lacked clear control. Riots and uprisings had started to break out all over the country, creating a situation of nationwide chaos. By late spring, 1787, more than thirty major disorders had developed in twenty different locations around the country, including in the cities of Nara, Osaka, Hiroshima, Hakata, Nagasaki, and Edo. This seventh year of the Tenmei era was plagued by the greatest degree of civil strife ever to take place during the entire two and a half centuries of the Edo period.

In mid-April, 1787, fourteen-year-old Tokugawa Ienari began his fifty-year reign as shogun, taking advice from Matsudaira Sadanobu, a feudal lord whose policies of local government austerity and aid to people in distress had made the famine less of a disaster in his do-

main in northeastern Honshu. In May, Hasegawa Heizo, a shogunate adviser whose father had been in charge of national civil security before him, was given the job of suppressing the disorders. Hasegawa succeeded in this role, and he spent the remaining eight years of his life modernizing shogunate policing methods, which had been designed to prevent civil unrest by keeping displaced and unemployed people under supervision and control.

In the case of the subsequent Tempo Famine of 1832 to 1837, the shogunate and the domain lords adopted relief measures similar to those originally undertaken during the Kyoho Famine, but years of repeated crop failures exhausted relief resources, and rice hoarding in less-affected areas continuously inflated the price of rice. As in the Tenmei Famine, the resultant regional disorders developed into urban uprisings as well. The largest of these occurred in Osaka in 1837, led by the retired official and neo-Confucian scholar Oshio Heihachiro. Oshio and his followers lost their lives in this abortive effort, while Ienari, who had begun as shogun following the peak of the Tenmei Famine in 1787, retired from office following the Osaka uprising.

SIGNIFICANCE

The Tenmei Famine, along with the Tempo Famine, contributed significantly to the depopulation of rural areas and to limited population growth in general because of the deaths of so many people from starvation and malnutrition.

Ienari's successor Ieyoshi followed the example of his father's work in 1787, and subsequently supported advisers who attempted to combine sweeping reforms with stricter policing of the people. As with Ienari, these reforms ended in failure because of the lack of sustained effort to carry them through, though authoritarian rule continued. Ieyoshi died soon after Commodore Matthew Galbraith Perry arrived in 1853 to secure a trade and commerce treaty between Japan and the United States, an event that disrupted Ieyoshi's own reign quite as much as the Tenmei Famine and Tempo Famine had undermined the reigns of his two predecessors.

During the seven decades between the start of the Tenmei Famine in 1782 and Perry's arrival in 1853, the military and civil power of the shogunate were progressively weakened by popular discontent

aroused by corruption, aggravated by a total of more than ten years of major famine and disorder. Beginning in 1853, the weakened shogunate attempted to maintain its control by a series of grudging compromises with Japanese regional enclaves and encroaching Western power, but the final result was the fall of the last Tokugawa shogun in 1867.

Michael McCaskey

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■ FEBRUARY 14, 1788

MEIKLE'S DRUM THRESHER IMPROVES HARVEST EFFICIENCY

Andrew Meikle innovated agricultural engineering implements and techniques. He improved mechanical threshing methods by creating a machine that enabled farmers to harvest grain crops efficiently. His invention occurred at a time when demand for agricultural goods increased dramatically to feed and clothe growing urban populations employed in industrial positions.

LOCALE: Scotland

AGRICULTURAL ISSUES: Innovations; Land and land policy; Mechanization; Textile industries

KEY FIGURES

Andrew Meikle (1719-1811), Scottish millwright

George Meikle (d. 1811), Scottish inventor and Andrew Meikle's son

Sir Francis Kinloch (fl. seventeenth century), Scottish agriculturist

John Rennie (1761-1821), Scottish apprentice to Andrew Meikle and civil engineer

SUMMARY OF EVENT

As British urban populations expanded in the eighteenth century due to industrialization, the demand for food urgently increased. British agriculture required intensive labor to cultivate fields and harvest crops during most of that century. Farmers attempted to grow greater yields to feed nonagricultural populations and supply raw fibers to textile mills. They had fewer laborers to help them, because many people abandoned rural work for urban employment. Enclosure laws forced many agricultural workers from land. Farmers sought to produce large quantities of foodstuffs with minimal labor. In order to do so, they needed technological assistance.

Most people considered agricultural work tedious and time-consuming. For centuries, engineers and inventors had experimented with implements and tools, attempting to create machinery to ease agriculturists' workloads. Jethro Tull's 1701 seed drill inspired inno-

vation. Farmers read agricultural guidebooks recommending ways to achieve success. Some agriculturists tested new methods and tried different equipment, adapting and designing tools suitable for their specific fields and needs.

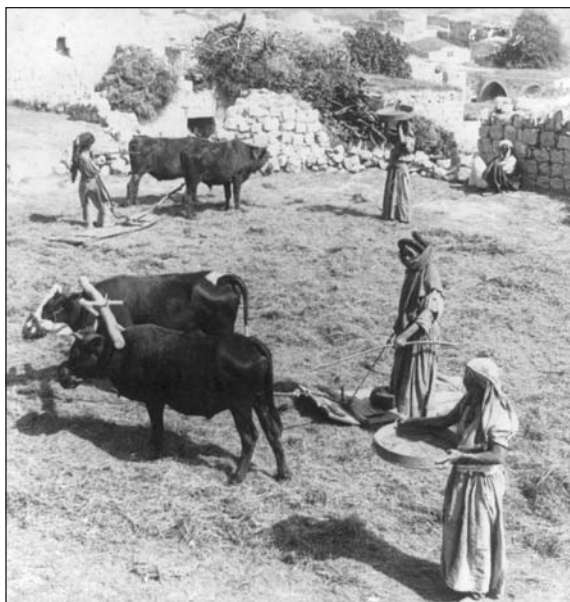
Scottish inventor Andrew Meikle envisioned a machine to ease the labor- and time-intensive threshing process usually performed by hand. Trained as a millwright by his father, James Meikle, Andrew Meikle understood mechanical processes. James Meikle had traveled to Holland in 1710 to examine Dutch agricultural technology and brought a winnowing machine to remove chaff from grain to the Meikles' East Lothian home. Andrew Meikle probably saw that equipment and gained experiences with his family's mill, grinding barley and corn, prior to building and repairing textile mills in Scotland from the 1740's through the 1760's with his brother, Robert Meikle. They also traveled throughout England, examining mills.

The Meikle brothers worked as consultants for the Scottish mills' board of trustees for manufactures. They advocated that the board provide money to educate apprentices. Andrew Meikle arranged for his neighbor, John Rennie, later a prominent civil engineer, to serve as his apprentice during the mid-1770's, while Meikle worked on threshing machine designs at his Houston Mill, close to East Linton on Haddingtonshire Tyne. He also taught future engineer William Playfair. The Meikles' experiences inspired them to improve technology used in both grain and textile mills. Aware of other people's inventions, they adjusted designs and created new versions of commonly used devices. By 1768, the pair received patent number 896 for a grain winnowing machine to remove husks.

Meikle's related inventions, prior to concentrating on threshing, strengthened his imagination. Intrigued by wind movement, Meikle focused his inventive talents on redesigning windmills. In 1750, Meikle created fantails to keep windmill sails at right angles to wind. By 1772, he secured a patent for windmill sails incorporating springs to permit hinged shutters to vent gusty winds, preventing damage to the sails and ensuring power generation crucial for milling needs was not disrupted.

Aware of farmers' concerns about labor shortages, Meikle considered designing better devices to help agriculturists profitably supply crops to markets. Farmers stated that threshing, the process of strip-

Middle Eastern farmers threshing grain without the help of mechanical equipment during the late nineteenth century. The woman in the foreground is winnowing threshed grain.
(Library of Congress)



ping grain from plant stalks, required the most time. Before they had access to dependable mechanized threshing, most eighteenth century agricultural laborers beat stalks with flails to remove grain. Meikle knew how equipment worked and wanted to make tools easier to use and more efficient to help farmers.

Meikle probably had seen mechanized devices used to beat flax with internal flails and knew of several models other inventors had designed to thresh grain. In 1636, Sir John Christopher had patented a simple threshing machine. A century later, Meikle might have been inspired by Michael Menzies's 1734 machine, built in East Lothian. Meikle might have learned about the machine Scottish farmer Michael Stirling created during the 1750's, which had wood beaters, often called scrutchers, that revolved like those sometimes used in lint mills to process flax. Sir Francis Kinloch redesigned a machine built by a Mr. Elderton and gave a model to the London Board of Agriculture and another to Meikle.

Meikle contemplated these prior attempts to mechanize threshers, studying varying designs and investigating why machines worked or failed to achieve their tasks satisfactorily and reliably. He noted that rubbing processes removed grain from stalks, but the pressure

caused bruising to kernels. Eager to apply his ideas for improvements, Meikle designed, built, and tested prototypes for a threshing machine during the 1770's and 1780's. He adjusted and rejected several designs until he realized what mechanisms would be most effective.

After approximately ten years of trials, sometime around 1787, Meikle envisioned using a revolving drum to remove grain from stalks. He placed rigid iron scrutchers around a drum cylinder. Meikle fed stalks through long, grooved rollers like those utilized in lint mills. Meikle's experience with flax machinery, which beat fiber out of flax, possibly inspired this idea. The drum spun quickly—more than two hundred revolutions per minute—to remove grain, as stalks were pounded against the concave metal container walls securing the drum. This machine met Meikle's expectations, because the drum design beat grain and did not rub it. He added devices to collect grain and remove chaff and debris. Andrew's son George Meikle constructed a threshing machine for a farmer and received orders to build more. When he told Kinloch his father would apply for a patent, Kinloch argued that Meikle's design was unoriginal.

On February 14, 1788, Andrew Meikle exhibited his water-powered machine at Knowes Mill, near Haddingtonshire. Observers told the area's board of trustees for manufactures what they had seen, praising Meikle's machine. Meikle received English patent number 1645 for that machine but was unable to secure a Scottish patent because he had demonstrated the machine and threshed grain in public. Aspiring to help farmers and earn income from machinery sales to consumers, Meikle built a factory in 1789.

Although many farmers were receptive to his machine and purchased it, Meikle did not profit from his invention. In the eighteenth century, patents rewarded inventors and were considered an honor, not necessarily a guarantee of property rights. People, including Kinloch, claimed they had invented Meikle's design and ignored his patent. Neither Meikle nor legal authorities enforced it. Copying Meikle's design, craftsmen built and sold hundreds of unlicensed machines. That competition hindered Meikle's sales. Despite his machine's importance and widespread use, Meikle earned minimal income. By 1809, Sir John Sinclair directed Meikle's friends to collect £1,500 to support him.

SIGNIFICANCE

Meikle's pioneering drum thresher represented a significant technological component of the late eighteenth century Agricultural Revolution in Great Britain. His practical, effective design revealed how engineering and scientific inventiveness and applications aided the industrialization and commercialization of agriculture. Meikle's thresher enabled farmers to process crops in less time, especially as farm sizes increased and labor sources decreased. That machine became the basis for future threshing technology, as some innovators improved his design. Since the 1780's, engineers have incorporated Meikle's design in combined harvesters used to cut, thresh, and winnow crops with one machine. Modern machines retain principles of Meikle's invention. Inspired by Meikle's threshing machine, inventors devised such related tools as reapers to process agricultural produce mechanically.

Most farmers in northern England and Scotland accepted Meikle's thresher because those regions lacked workers due to industrialization employment demands. The Lowland Clearances had forced many rural Scots to relocate to urban areas or emigrate. Although technology usually advanced agriculture, many agricultural workers were affected negatively. In southern England, where more corn grew, thus increasing threshing demands, farm laborers resented Meikle's machine because they could not compete with mech-



Aultman-Taylor threshing machine of the 1880's. (Library of Congress)

anization's efficiency. Denied threshing jobs they had relied on to earn income, human threshers suffered unemployment and poverty because factories could not hire all available labor or those jobs did not appeal to rural residents. Workers' frustration and anger grew over the following decades as more farmers used threshing machines. Large farms expanded, and investors, often absentee, embraced technology to gain profits. Those owners were usually uninterested in the welfare of rural communities and laborers. Displaced workers rioted in 1830, damaging threshing machines and burning agricultural buildings and supplies while praising fictional renegade Captain Swing.

Elizabeth D. Schafer

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discussing agriculture advances that coincided with Industrial Revolution technological innovations. Argues that threshing machinery reduced labor but did not increase yields.

SEE ALSO: 1701: Tull's Seed Drill Revolutionizes Farming; 1793: Whitney's Cotton Gin Transforms Plantation Agriculture; Summer, 1831: McCormick's Mechanical Reaper Transforms Wheat Farming; August 12, 1902: International Harvester Begins Manufacturing Farm Machinery.

WHITNEY'S COTTON GIN TRANSFORMS PLANTATION AGRICULTURE

Eli Whitney invented a machine to separate the useful portion of the cotton plant from its seeds and other extraneous materials. The gin revolutionized methods of agricultural production and increased the demand for slave labor in the American South.

LOCALE: Georgia, United States

AGRICULTURAL ISSUES: Food processing; Labor; Mechanization; Slavery; Textile industries

KEY FIGURES

Eli Whitney (1765-1825), American inventor

Catherine Greene (1753-1814), friend of Whitney

Phineas Miller (1764-1803), Whitney's business partner

Sir Richard Arkwright (1732-1792), English inventor of the water frame for spinning cotton

Edmund Cartwright (1743-1823), English inventor of the power loom

Samuel Crompton (1753-1827), English inventor of the spinning mule

J. D. B. De Bow (1820-1867), editor of *De Bow's Review* in New Orleans and apostle of southern diversification

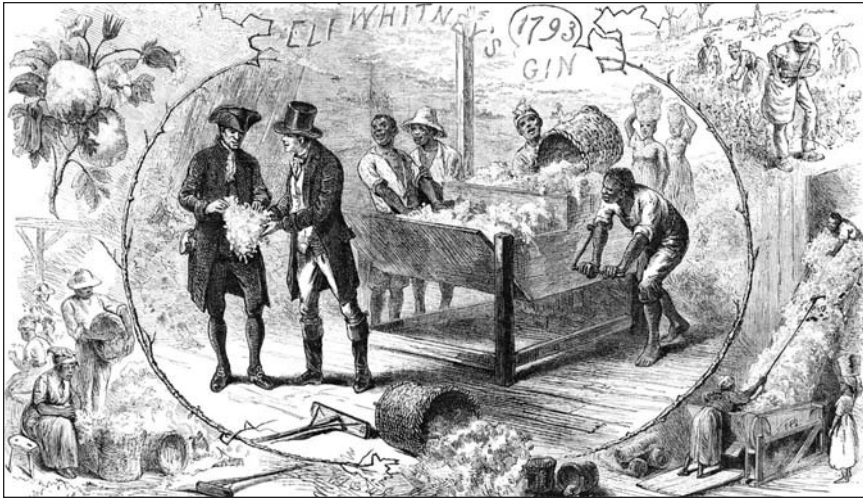
James Hargreaves (1720-1778), English inventor of the spinning jenny

Edmund Ruffin (1794-1865), American advocate of scientific farming

James Watt (1736-1819), English developer of the steam engine

SUMMARY OF EVENT

Eli Whitney was born December 8, 1765, in Westborough, Massachusetts. The eldest of four children in a middle-class farming family, he had exceptional manual dexterity and a very inquisitive mind. The young Whitney particularly enjoyed dismantling mechanical devices and putting them back together. He also liked to build things in his father's workshop. This early curiosity continued to manifest itself throughout his teenage years and led to a degree from Yale College in 1792.



African American plantation workers operating a cotton gin. (Library of Congress)

Following his graduation from Yale, Whitney decided to take a position in South Carolina as a tutor. On his journey south, he became acquainted with Catherine Greene, who persuaded him to visit her home near Savannah, Georgia. Whitney decided to stay at the Mulberry Grove plantation. It was there that Greene first suggested to Whitney that he invent a machine to clean the seeds from cotton. According to Whitney's personal account, he built that first small-scale model of the cotton gin in about ten days. He showed it to Greene and her plantation manager, Phineas Miller, who encouraged Whitney and financed the gin's development. Whitney made several adaptations to the already existing machines (which he had never seen), and the completed model of the cotton gin took months to finish.

Whitney's genius did not bring him the financial rewards he expected. The gin was of such great general utility that the South refused to allow anyone a monopoly on production of the machine and, as a result, there was much pirating. Whitney's problems with the gin and the patent struggles in which he engaged affected his approach to the rest of his industrial career. He was willing to improve the efficiency of his shop only if it did not threaten his security. He designed a musket-barrel-turning machine, for example, but did not build it for fear that competitors would use it to lure away his trained

workmen. Whitney's business abilities were not outstanding. He was primarily interested in the mechanics and efficiency of production, but in those early days an entrepreneur had to be his own chief engineer, foreman, salesperson, and public relations expert. Only in the latter part of the nineteenth century did industrial specialization become common.

The invention of the cotton gin by Whitney was one of several important technological advances during the eighteenth century that revolutionized methods of production and habits of consumption throughout Europe and the United States. Whitney did for the cotton planter what Sir Richard Arkwright, James Hargreaves, Edmund Cartwright, and Samuel Crompton had done for the cotton manufacturer in Great Britain. The cumulative result of the water frame, the spinning jenny, the power loom, and the spinning mule was to increase the demand in England for raw cotton, and the cotton gin made it possible for U.S. planters to meet that demand. The application of steam to these machines greatly increased the output of yarn and cloth, thus serving to intensify the demands made upon cotton plants in the United States.

SIGNIFICANCE

The growth of the cotton industry in the United States was a major force in the rapid economic development of the nation, and much credit for this fact must go to the invention of the cotton gin. The period of the industry's greatest growth followed hard upon the end of the War of 1812, in 1815. Cotton production in the United States rose from 364,000 bales in 1815, of which 82 percent was exported, to 4,861,000 bales in 1860, of which 77 percent was exported. By 1860, Great Britain was consuming one quarter of the entire U.S. crop. Cotton was the United States' leading domestic export. In 1860, the total value of U.S. exports reached \$334 million, 57 percent of which was from cotton. If the value of exports of other southern staples, notably tobacco, sugar, and rice, is added to this figure, the contribution of the South to the nation's export trade approached 65 percent. In spite of these impressive statistics, southerners complained that the fruits of their labor were gathered by other sections of the country.

To a large degree, this charge was accurate. Southern planters

sold their crops abroad or to the northeastern states. The market was erratic, varying according to demand and supply; it was sensitive to international incidents and almost impossible to predict. Communications were slow. Planters shipped according to one set of prices, only to find a different set of prices operative when their cargoes arrived in port. Risks at sea were great. The costs of shipment were large and paid in the form of commissions to agents of the planters. These men, called factors, handled every detail of the shipment, in addition to making purchases for, and offering credits to, the planters.

These problems were common to all the participants of the staple trade, but they fell with greater impact, especially after 1830, on the older cotton-producing regions along the South Atlantic coast. There, constant plantings without attention to soil conservation reduced yields per acre while increasing costs of production per unit of crop. South Carolina planters found it extremely difficult to compete with planters on Mississippi's lush and virgin lands. Economic stagnation and nullification inevitably followed. Another result was an effort on the part of some farsighted southerners to stimulate economic diversification in the region. J. D. B. De Bow of New Orleans and Edmund Ruffin of Virginia were among those who preached the virtues of scientific agriculture, industrialization, and transportation improvements.

The dramatic growth of the cotton plantation was more than a matter of production statistics and marketing problems. It was the story of great movements of population into the lush lands of the lower Mississippi River Valley. It was also the story of the master and the slave. To some historians, particularly those from the South, it was the story of the evolution of a culture distinct from that of other regions. Most historians, including those who deny the concept of cultural distinctiveness, agree that by the 1850's—according to most economic indices—the South was in a manifestly inferior economic position, perhaps in a colonial position, relative to the North. Most also would agree that the institution of slavery was a major cause of this inferiority.

The North was not an industrial area in 1860, although strong beginnings had been made in some parts. The North was basically agrarian but was more industrialized than the South. This meant that the North offered more nonagricultural opportunities for economic



*Tuft of cotton
waited to be picked
and have its seeds
removed by a cotton
gin. (PhotoDisc)*

advancement. The agricultural sector in the North was based on the small farm. In the South, by contrast, small farmers found it increasingly difficult to compete with the plantation.

The size of individual landholdings increased markedly in the South after 1840, while farms became smaller in the North. The population of the North was compact; the plantation system dispersed population in the South, retarding southern town and city development. Fewer urban areas meant there were fewer commercial and banking facilities in the South, which, in turn, meant a slow rate of capital formation and presented difficulties to those wishing to diversify or undertake transportation improvement. Fewer inducements were available to attract skilled labor, and the fear of competing with slaves was also an obstacle. At the same time, the need for unskilled labor—specifically African American slave labor—was increasing as the South struggled to meet the growing demand for cotton made possible by the new technology.

The effect of all these factors was to make the South economically weaker than the North, although the South was integrated in the budding national economy. The South was neither distinct nor unique, but as pressures on, and criticism (particularly abolitionist criticism) of, the South accumulated, southerners created the myth of their cultural uniqueness. Whitney's invention had done much to make this myth—and a growing North-South schism—possible.

John G. Clark, updated by Liesel Ashley Miller

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■ MAY 6, 1795

SPEENHAMLAND SYSTEM AIDS ENGLISH FARMERS

The county magistrates of Berkshire, England, modified an existing system to help poor farmworkers. They linked the amount of money given to the poor to the price of bread, so workers would automatically be paid more money as bread became more expensive. Such “index-linking” schemes became widely adopted and remained in place until a new Poor Law was enacted in 1834.

LOCALE: Speenhamland, near Newbury, Berkshire, England

AGRICULTURAL ISSUES: Agrarian reform; Government policy and regulation; Labor; Marketing and trade; Price supports and controls

KEY FIGURES

Thomas Gilbert (1720-1798), English reformist member of Parliament
Samuel Whitbread (1764-1815), English reformist member of Parliament

William Pitt the Younger (1759-1806), British prime minister, 1783-1801, 1804-1806

SUMMARY OF EVENT

By the end of the eighteenth century, there had been a poor law in England since late in the reign of Elizabeth I (1601). A “poor law” is legislation designed to aid the poor, whether their poverty arises from disability, unemployment, or low wages. The Elizabethan Poor Law raised money for such aid from local parish rates (taxes), which were supervised by local magistrates.

By the second half of the eighteenth century, the system was beginning to break down in certain, mainly rural, areas. As a result of agricultural reforms, landowners were enclosing land, thereby preventing farmworkers from grazing animals on “common” land. Nor did all farmers supply their workers with housing that included yards in which animals could graze. From 1760 onward, the pace of enclosing land increased. It is reckoned that 95 percent of enclosure legisla-

tion injured the poor, as the increase in the number of completely landless laborers increased the level of poverty. Poverty was also exacerbated by increases in seasonal unemployment. Contemporary observers demonstrated that it was no longer possible for an agricultural worker to subsist on the wages he earned.

Some politicians, for example Member of Parliament Thomas Gilbert, saw the need to reform the Poor Law to take account of these changes. He had been a land agent for the second earl of Gower—the future marquess of Stafford and one of the nation's wealthiest landowners—and he had seen for himself the effects of enclosure. In 1765, he began a campaign for the better organization of parish relief and for more accountable oversight. His efforts were consistently defeated until 1782, when he introduced three bills into Parliament. The first two bills passed and became law, enabling local parishes to supplement low wages from the rates and to create work for the unemployed. Infirm paupers were to be kept in workhouses. Guardians were to be appointed to administer relief.



Modern Berkshire farmland on a rainy day. (©Sandyprints/Dreamstime.com)

MAY 6, 1795

The Gilbert Act helped alleviate the British poverty level, but it did not fix a national system of supplementing income. In the north of England, agricultural workers were paid better than in the south or the Midlands, because there was a shortage of such workers in that area. The Industrial Revolution was beginning, and the mills and factories that had begun springing up and draining the potential labor pool were centered in the north. Industrial rates of pay were typically higher than rural wages, so northern farms had to increase their wages to compete. Elsewhere, though, wages were kept low, despite the beginnings of the Napoleonic Wars in 1793 and a series of bad harvests, which drove up food prices. Taxation also rose sharply. Food riots occurred in 1795 to protest the growing disparity between wages and prices.

In the county of Berkshire in the south of England, eleven local magistrates—five landowners and six clergymen—met at the Pelican Inn in the village of Speen, near Newbury, on May 6, 1795, to consider the plight of the farmworkers and to discuss the problem of parish relief. They decided to set a standard for the amount of relief, or supplemental wages, to be paid to poor workers out of parish funds. They based their standard on the assumptions that a man consumed twenty-six pounds of bread per week and a woman or child consumed half that amount.

The magistrates agreed to fix the index at the cost of a “gallon loaf” of bread, that is, one weighing eight pounds and eleven ounces, made of second-grade-quality flour. Thus, if such a loaf cost one shilling, then each laborer in the county was to receive a total income of three shillings a week plus one and one-half shillings each for his wife and children. If the price of bread rose to one and one-half shillings per loaf, then the total minimum income would increase to four and one-quarter shillings per laborer and two shillings per dependent (wife or child). The difference between a worker’s actual income and his minimum permissible income according to the index was to be paid to each household from money raised through the parish rates.

This payment of supplemental wages based on the price of bread came to be known as the Speenhamland system. It was a practical solution arrived at by local authorities, not a piece of legislation, and there were other systems already in practice elsewhere in England. Indeed, Prime Minister William Pitt the Younger opposed any fur-

ther government intervention in the form of national poor laws or wage regulation. In 1796, Samuel Whitbread, the son of a millionaire brewer, attempted to introduce a parliamentary measure for a minimum national wage, and it failed in the face of Pitt's opposition. In the absence of such a national measure, most parishes in the south and the Midlands of England quickly adopted the Speenhamland system.

The system did not prevent further unrest: Food riots took place in 1796, 1800, and 1801. Moreover, larger landowners tended to profit by the system. Although they contributed more to the rates, their workers also received more from them. Smaller farmers had less need of laborers, but they still had to contribute substantially to the parish rates. For example, a farmer in 1816 holding three hundred acres of land had to pay £380 per annum in rates and taxes, plus one-tenth of his income as a tithe to the Anglican Church. A number of smaller farmers went bankrupt.

The price of wheat fluctuated enormously as a result of poor harvests and the wars, rising from a little more than 52 shillings per quarter in 1794 to 119.5 shillings per quarter in 1801. The restrictive Corn Laws of 1791, 1804, and 1815 kept the price of wheat high, so the Speenhamland system became increasingly difficult to budget for and expensive to operate. Farmers refused by and large to raise wages. A typical farm laborer's wage was twenty-six pounds per annum (ten shillings per week), while women and children would only receive five shillings and three and one-half shillings per week, respectively. After the Napoleonic Wars, taxes shifted from direct to indirect, so the tax burden fell disproportionately on the poor, as many necessary items for living came to be taxed. During the 1830's, a series of riots called the Swing Riots broke out in the southern counties, as living conditions there deteriorated even further.

SIGNIFICANCE

The success of the Speenhamland system is hard to assess. Some social historians believe it worked against the working classes by keeping wages low, by demoralizing them, and by keeping them dependent upon handouts. Under the system, however hard a man worked, he ended up receiving the same amount of money each week. Other historians, however, believe the Speenhamland system prevented

MAY 6, 1795

starvation and revolution in a time of massive social change and in fact acted in the same way as a minimum wage.

During the period in question, there was a change away from the eighteenth century philosophy of patronage and humanitarian duty on the part of the landowning classes to a nineteenth century philosophy of laissez-faire economics. Proponents of the new economics suggested that the Speenhamland system encouraged large families and thus rural overpopulation, while it prevented market forces from operating properly. There was general contemporary agreement that if the laboring classes were not kept fractionally above the starvation level, they would not work hard. Even enlightened reformers like William Wilberforce subscribed to such views. Thus, ideological opposition to the system grew.

In addition to theoretical and philosophical opposition, there was growing dissatisfaction with the system on a practical level. The amount spent nationally on Poor Law relief was growing dramatically. For example, in 1784, £2 million was spent annually; by 1813 this figure was £6.5 million; and in 1818 it had reached £8 million. The result was that in 1832 a royal commission was set up to look into the workings of the Poor Law, under the able direction of Nassau Senior and Edwin Chadwick. The commission's eight-thousand-page report was published in 1834, and in that year Parliament passed the Poor Law Amendment Act, setting up a nationally administered system and bringing the Speenhamland system to an end. Thus, the system could best be seen as an evolutionary transition in social reform, as local parishes moved to take action in an arena that would later be seen as the necessary purview of the nation.

David Barratt

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■ SUMMER, 1831

McCORMICK'S MECHANICAL REAPER TRANSFORMS WHEAT FARMING

Cyrus McCormick's invention of the earliest commercially successful mechanical reaper dramatically reduced the need for labor and made large-scale wheat production possible.

LOCALE: Walnut Grove, Virginia

AGRICULTURAL ISSUES: Innovations; Labor; Mechanization

KEY FIGURES

Cyrus Hall McCormick (1809-1884), inventor of the reaper

John Deere (1804-1886), manufacturer who introduced the steel plow in 1837

Obed Hussey (1792-1860), inventor of a competing reaper

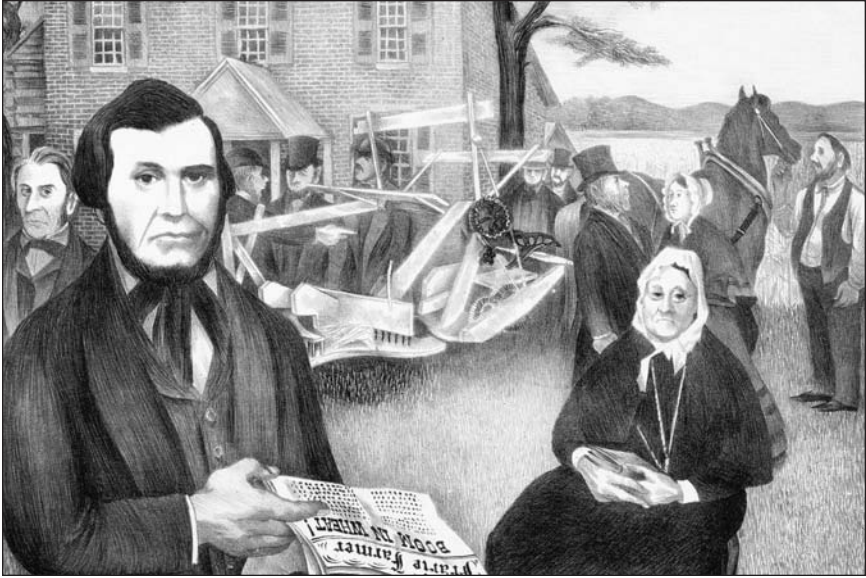
John H. Manny (1825-1856), manufacturer of farm implements

SUMMARY OF EVENT

Wheat is a crop that historically presented a special challenge to farmers because of its short harvest period. After it ripens, its husks begin to open and begin rotting if they are not harvested within ten days. Before the development of mechanical harvesters, farmers had to be careful not to plant more wheat than they could harvest with the limited supply of labor available to them. Labor shortages on American farms made the development of mechanical reapers a pressing need during the early nineteenth century.

Cyrus Hall McCormick is generally credited with the invention of the first reaper containing the basic elements that are still used in modern reaping machines. Other inventors in the United States and Great Britain produced working models of mechanical reapers before McCormick did, but none of their inventions proved commercially successful. For example, in Great Britain, Thomas Brown manufactured and marketed a mechanical reaper before 1820, but its sales were slow because farm labor in Britain was more plentiful and cheaper than in the United States, and because British farms typi-

McCormick's Mechanical Reaper Transforms Wheat Farming



Modern painting by Bernarda Byrson (1903-2004) showing Cyrus McCormick standing in front of his reaper, holding a newspaper with the headline "Boom in Wheat!" (Library of Congress)

cally had small fields that made the use of mechanical reapers difficult.

McCormick developed his reaper on a twelve-hundred-acre family farm of Walnut Grove in Virginia's Shenandoah Valley. The problem of a mechanical reaper had intrigued McCormick's father, Robert McCormick, who had attempted to build one several times. Robert McCormick used tools and materials available in the farm's blacksmith shop and did not succeed. During the summer of 1831, however, his son Cyrus built a reaper that performed successfully. The younger McCormick then set the invention aside for several years to pursue other business interests. It was not until 1834, after a failed attempt to market a hemp-breaking machine invented by his father, that Cyrus resumed work on the reaper and applied for a patent.

McCormick's reaper revolutionized grain farming in the United States. Prior to its invention, the methods used in harvesting grain had not changed in thousands of years. Harvesting was done with hand-held scythes and cradles, with teams of rakers and binders following behind. As workers with scythes or sickles cut the grain, other

workers raked the fallen stalks, and binders gathered the stalks into bundles known as sheaves. The sheaves then were stacked into piles (shocks) to await collection into wagons.

Harvesting was backbreaking work and resulted in much waste. According to technology historian Harold Livesay, in 1830 a crew of six laborers—one worker cutting the wheat with the others following behind, raking and binding—could harvest only two acres per day. During the 1840's, the McCormick reaper could handle between ten and fifteen acres per day and required fewer binders following behind. The substantial savings in labor allowed a relatively small workforce to at least triple the acreage harvested.

By 1839, when McCormick started advertising his machine, other reapers already had entered the market. A former sailor from Maine, Obed Hussey, had patented a mechanical reaper in 1833 and had been selling reapers for several years. Hussey was McCormick's first serious competitor. In 1840, McCormick sold only two reapers; both of them broke down, so he returned to his workshop to improve his reaper's design. In 1842, he sold six machines; in 1843, twenty-nine.

During this initial period, most of the reapers in use were in the eastern states, although McCormick's machines had been built in Ohio. McCormick had visited the prairie states, however, and knew that was where the reaper would be in highest demand, as farming, particularly the production of grain crops, was moving west. In 1848, McCormick moved to Chicago and built a factory to manufacture reapers. This location offered several advantages. Transportation from Chicago was already good and was getting better with the construction of new railroad lines in Illinois and west of the Mississippi River. Also, Illinois and Wisconsin were becoming the major grain-producing states, and the broad, level wheatlands of the West could employ mechanical reapers more efficiently than the smaller and often hilly and rocky wheatlands of the East.

McCormick's reaper factory in Chicago helped make that city a center for the manufacture of agricultural machinery in the United States. During 1849, the first full year that McCormick manufactured machines in Chicago, his factory produced fifteen hundred reapers. By 1858, sales of his reaper had made McCormick a millionaire.

Mechanization of farming brought many changes to American agriculture. In 1830, the total wheat crop of the United States had

amounted to approximately 40 million bushels. Within nine years, this figure doubled, and in 1860 it exceeded 170 million bushels. During the 1830's, New York, Pennsylvania, and Virginia were major wheat-producing states, but the center of the wheat-growing area moved steadily westward. In 1839, the Old Northwest produced 31 percent of the nation's crop; in 1849, 37 percent; and in 1859, 46 percent. A reason for the dramatic increase in wheat production was the introduction of the McCormick reaper.

As the domestic economy grew, stimulated by the immigration of large numbers of Europeans after the late 1840's, the demand for wheat and other grains increased proportionately. From 1846 to 1860, prices were fairly high, and farmers throughout the states of Ohio, Indiana, Illinois, and Wisconsin expanded their acreage in wheat. Before the U.S. Civil War (1861-1865), wheat was the most important cash crop in the northern agricultural economy, and by 1860 it was the most important cash crop in the United States. Its importance was largely the result of the growth of the domestic economy rather than of the entrance of American grain and flour into European markets. The development of a nationwide transportation system of canals and railroads allowed farmers in formerly isolated regions to participate in the market economy. Crops such as wheat that had been prohibitively expensive to transport by wagon were transported cheaply and easily by rail.

SIGNIFICANCE

The reaper had a significant impact prior to and during the Civil War (1861-1865). Reapers sold by McCormick and his strongest competitor, John H. Manny, were common in northern Illinois and southern Wisconsin during the 1850's. One authority estimated that more than seventy thousand reapers and mowers were in operation west of the Appalachians by 1858. By 1860, about 70 percent of the wheat harvested in that area was cut by machine. By 1864, about 250,000 reapers and mowers were in use in the North, enough to provide machines for 75 percent of all northern farms of more than a hundred acres. A significant number of these machines came from the growing production lines of Cyrus H. McCormick. His profits from sales in 1856 reached three hundred thousand dollars; between 1868 and 1870, annual sales were double what they had been during the war,

and the factory on the Chicago River produced eight thousand reapers and mowers for harvest each year.

The mechanization of agriculture and the establishment of Chicago as a center of production came just in time to service the movement of the center of grain production into the trans-Mississippi country. The semiarid prairies of Kansas, Colorado, and Nebraska demanded farming on a large scale. Machinery was necessary. Similarly, the movement of wheat into the bonanza farms of California required machinery. The inventive genius of McCormick, Hussey, Manny, John Deere, and others made it possible to prepare, seed, tend, and harvest thousand-acre wheat farms with relatively small workforces. McCormick did for wheat what Eli Whitney had done for cotton.

John G. Clark, updated by Nancy Farm Mannikko

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■ OCTOBER 14, 1834

BLAIR'S SEED PLANTER ADVANCES CORN AND COTTON FARMING

Henry Blair's corn and cotton seed planters helped advance the agricultural revolution of the early nineteenth century in the United States at a time when most African Americans were enslaved and when free blacks were fighting for the basic rights of citizenship. Until his first patent in 1834, only one other African American inventor—Thomas L. Jennings—had applied for and received a patent.

LOCALE: Maryland

AGRICULTURAL ISSUES: Draft animals; Innovations; Mechanization; Slavery; Textile industries

KEY FIGURES

Henry Blair (1804-1860), African American inventor

Thomas L. Jennings (1791-1859), African American inventor

SUMMARY OF EVENT

Born in Montgomery County, Maryland, and living and working at a time and place hostile to people of African American descent, Henry Blair is the only inventor described as “a colored man” in the records of the U.S. Patent Office. His corn seed planter, patented on October, 14, 1834, allowed farmers to plant more corn in a shorter period of time. The corn planter, which was pulled by horses or oxen, dropped individual kernels of corn into furrows, which were then automatically covered with earth as a farmer walked behind the planter. Blair's cotton planter, patented two years later in 1836, was equally instrumental to the agricultural revolution that began in the United States during the first half of the nineteenth century.

It was earlier thought that Blair was the first African American to receive a patent, but Thomas L. Jennings, a free black tailor living in New York City, patented a dry-cleaning process in 1821. Along with the products of other inventors, such as John Deere (who invented a steel plow that allowed for the cultivation of the midwestern prairie

ries), Blair's planters led to significant increases in American farm production.

Little is known about Blair's early life, but it is assumed that he was a free man, as enslaved people were not allowed to obtain patents. It is also evident that he could not read or write because he signed his patents with an X. His experiences in antebellum American society (before the Civil War) likely were similar to those of many other free blacks who lived in the South: plagued by continual fear and intimidation. The percentage of free blacks in the antebellum South actually declined during the period between 1815 and 1860. During the colonial period and immediately following the Revolutionary War (1775-1783), many enslaved Americans either were granted freedom by their masters (who sometimes felt guilty about their ownership of slaves, given the egalitarian rhetoric of the revolutionary period) or were able to purchase their own freedom as well as the freedom of family members.

After the invention of the cotton gin by Eli Whitney in 1793, however, the changing agricultural economy made it more difficult for slaves to gain their freedom. The cotton gin made it economically feasible to separate the seeds from raw cotton and allowed for more and cheaper cotton to reach the world's textile markets. Cloth manufacturers in England and the northeastern United States could process as much cotton as the American South could produce. Because slaves were the primary source of labor in the southern states, they were also in greater demand. When the cost of slave labor increased, people who had earlier been able to purchase their own freedom were priced out of their own "market." Masters were less willing to let go of their slaves, whose monetary value increased throughout the first half of the nineteenth century.

The free blacks who lived in the South during this period faced increasing dangers of enslavement or re-enslavement. Unscrupulous slave catchers often abducted free blacks and claimed that they were escaped slaves. Restrictions on the movements of free blacks during the antebellum period also grew more severe. Particularly after the planned Denmark Vesey slave rebellion of 1822 in South Carolina and the Nat Turner Rebellion (1831) in Virginia, slave owners (and their supporters in the government) required free blacks to carry manumission papers and to register with local authorities. The edu-



Plantation foreman weighing cotton as field workers bring in baskets of their pickings.
(Library of Congress)

cation of enslaved people was prohibited. The inability to acquire an education made it difficult for African Americans to enter and progress in the professions; however, the lack of an education did not prevent Blair from capitalizing on his knowledge of the mechanical arts. Fearing that free blacks might aid in the escape of slaves to the northern states or Canada, the Maryland legislature passed an 1841 act that prohibited their possession of abolitionist literature; conviction under the act carried a prison sentence of ten to twenty years.

It is often assumed that slavery in Maryland was not as harsh as in states of the Deep South. Some point to the presence of the Quakers (particularly along the state's eastern shore) as a factor that might have lessened the severity of the institution. According to Frederick Douglass, a leading abolitionist from Maryland who escaped from slavery, the institution was just as harsh in Maryland as it was in other states. Even though the physical climate and work conditions were not as difficult as in the Deep South, enslaved people and free blacks in Maryland suffered from the constant fear that they or their family members could be sold to the cotton plantations of Mississippi and

Alabama. For abolitionist Harriet Tubman, also a Maryland resident and a slave, these fears became reality. When she was twenty-eight years old she learned that she and other members of her family were to be transported to the South. She had been married for five years to John Tubman, a free black man. After an unsuccessful first try at escape, she eventually escaped to the North and then returned many times to the South to help more than three hundred slaves escape as well.

It is not clear why Blair continued to reside in Maryland, given its increasingly hostile and unsafe environment. Like many free blacks in the antebellum South, he may have had enslaved family members in the area. In any case, he was able to continue his work as an inventor while living under conditions that required constant vigilance and care.

The information that is available about Blair and other African American inventors is largely based upon the work of Henry Baker, an assistant patent examiner in the federal Patent Office during the late nineteenth century. At the turn of the century, the Patent Office sent letters to patent attorneys, newspaper editors, and prominent African Americans to gather information about black inventors. Baker compiled the information and followed leads, publishing his results in the four-volume work *The Colored Inventor: A Record of Fifty Years* (1913). His research was used to select inventions for exhibition at the New Orleans Cotton Centennial in 1890, the Chicago Columbian Exposition in 1893, and Atlanta's Cotton States and International Exposition in 1895.

SIGNIFICANCE

Henry Blair's work as an inventor in antebellum Maryland marks him as both an innovative mechanic and a brave human being. Laboring as a successful farmer in a social climate that engendered fear and anxiety in both free and enslaved African Americans, he was able to produce and receive patents for two important inventions: a corn planter in 1834 and a cotton planter in 1836. In doing so, he was only the second African American to register a patent in the United States.

Blair pioneered the way for other African Americans such as George Washington Carver, an agricultural scientist who worked dur-

GEORGE WASHINGTON CARVER

Far better known than Henry Blair, George Washington Carver (c. 1864-1943) was an African American agricultural scientist who had been born into slavery in Missouri. Emancipation enabled him to get a public education in Kansas and a college degree from Iowa State University in Ames in 1894. Afterward, he joined the Iowa State faculty and earned a master's degree in agriculture in 1896. He then became director of the agricultural experiment station at Tuskegee University in Alabama. There he devoted his career to developing sustainable agriculture for the South, emphasizing peanuts and sweet potatoes as supplements or alternatives to cotton. He found numerous new uses for peanuts and sweet potatoes, such as dyes, milk substitutes, and cosmetics.

ing the late nineteenth century and early twentieth century, as his inventions, and those of others such as Eli Whitney, Cyrus McCormick, and John Deere, helped American farmers increase production and efficiency. Blair's contributions are all the more remarkable because he worked and succeeded in a repressive, prejudiced, and discriminatory social climate.

Kay J. Carr

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■ 1840

LIEBIG DEVELOPS CHEMICAL FERTILIZERS

Liebig's research in plant biochemistry led him to recommend the use of artificial fertilizers to increase crop yields. He also studied animal biochemistry and pioneered the production of meat extract and infant formula. Although some of his ideas later proved incorrect, he advanced the understanding of biochemistry, and his chemical principles led to increased food production.

LOCALE: Giessen (now in Germany)

AGRICULTURAL ISSUES: Botany; Chemistry; Fertilizers; Innovations; Scientific research

KEY FIGURES

Justus von Liebig (1803-1873), German chemist and professor
Nicolas-Théodore de Saussure (1767-1845), Swiss chemist and plant physiologist

Sir John Bennet Lawes (1814-1900), English agriculturist

Sir Henry Gilbert (1817-1901), English agricultural chemist

SUMMARY OF EVENT

During medieval times, European agriculture slowly increased in efficiency, but the greater demands placed on the soil commonly depleted it of nutrients. The only thing that farmers generally put back into the soil was farm-animal manure. Only in the eighteenth century did an understanding of the basic chemical principles underlying plant nutrition and soil fertility begin to develop significantly. Scientific insights included a greater understanding of photosynthesis, the process by which plants convert water, carbon dioxide, and light into the organic compounds they need to survive. In 1804, Nicolas-Théodore de Saussure demonstrated that plants obtain the carbon and hydrogen they need for photosynthesis from atmospheric carbon dioxide and water, respectively. He also found that they get the rest of the nutrients they require—nitrogen and mineral elements—from the soil.



Wagon pulled by a mule team spreading chemical fertilizer on a Georgia farm around 1940. (Library of Congress)

Over the next few decades, many researchers ignored Saussure's findings, believing instead that plants obtain their nutrients by absorbing complex organic molecules from humus in the soil. This theory was struck down by German chemist Justus von Liebig, who, as a professor at the University of Giessen, had already pioneered research in pure chemistry and, during the late 1830's, had turned his attention to the chemistry of life processes and to boosting food production to help feed the growing European population. In his 1840 book *Die Organische Chemie in ihre Anwendung auf Agricultur und Physiologie* (*Organic Chemistry in Its Applications to Agriculture and Physiology*, 1840), Liebig argued, more forcefully than had de Saussure, that plants obtain their nourishment from inorganic substances and that atmospheric carbon dioxide is the source of plant carbon.

Liebig recognized, as had de Saussure, that in addition to carbon, hydrogen, oxygen, and nitrogen, plants require a number of minerals for metabolism and growth, and they absorb these metals and salts as inorganic ions dissolved in the soil solution. The essential mineral nutrients are now known to include potassium, calcium, magnesium, phosphorus, sulfur, and, in lesser amounts, chlorine, iron, manganese, boron, zinc, copper, and molybdenum.

Harvesting crops removes the nutrients contained in those crops, rather than allowing them to be recycled to the soil through decomposition of the plants. As a result, the soil becomes depleted of mineral nutrients (in contrast to the supply of carbon from atmospheric carbon dioxide, which does not become exhausted). If farmers do not replenish the soil, one or more mineral nutrients will become deficient and crop yields will decrease. Liebig maintained that inorganic fertilizers are more effective than manure for restoring the soil and pioneered in advocating the use of artificial fertilizers. His book was especially influential in England, where much experimental work on Liebig's fertilizer theories was subsequently conducted.

With regard to one of the plant nutrients, nitrogen, Liebig's book contained an error that was to impede the reception of his overall message about fertilizers. He stated erroneously that plants obtain nitrogen, which is needed to manufacture proteins and other plant substances, from atmospheric ammonia dissolved in rainwater and absorbed by the roots. In reality, there is far too little ammonia in the atmosphere to supply the nitrogen needed by many crop plants. Like Saussure, however, he understood that, even though the atmosphere



Modern mechanized equipment used for spreading chemical fertilizers over fields.
(PhotoDisc)

is 78 percent elemental nitrogen, plants cannot use it directly. As was learned after Liebig's time, plants depend on various soil bacteria to convert elemental nitrogen to a form that the plants can absorb.

In 1845, using a formula devised by Liebig, the English industrial firm Muspratt and Company manufactured an artificial fertilizer that contained the important mineral nutrients potassium and phosphate, as well as a small quantity of ammonia salts. The fertilizer was a failure, partly because, to prevent it from being washed away by rain, Liebig had specified the use of insoluble forms of the minerals, which plants were unable to absorb. A few years later, the ability of soils to retain soluble mineral salts, regardless of rain, was demonstrated, and plants were shown to absorb these salts much more easily than insoluble ones.

Even after Liebig recognized his error and more soluble formulations were applied, the results were still poor because of Liebig's failure to realize the importance of adding nitrogen to the soil. Agriculturist Sir John Bennet Lawes, working with Liebig's pupil Sir Henry Gilbert at Rothamsted, England, showed through field trials that Liebig's formula provided insufficient nitrogen to boost crop growth. Nitrogen is now known to be the major nutrient limiting crop-plant growth.

Liebig was correct, however, in stressing the importance of phosphate and potassium—two nutrients that, in addition to nitrogen, are the major components of modern fertilizers. His promotion of phosphate was particularly successful. Farmers had long fertilized their fields with animal bones, but Liebig suggested that bone phosphorus would be more soluble, and thus more available to plants, if it were pretreated with sulphuric acid. Lawes, in 1842, patented a process for treating phosphate rock with sulfuric acid and subsequently launched the first superphosphate factory.

There was an important additional insight in Liebig's mineral theory: An artificial fertilizer containing a single nutrient will boost crop yield only if the soil can supply all the other nutrients that are needed. Thus, the essential nutrient that is in least supply is the controlling factor. This generalization, known as Liebig's law of the minimum, is still a central concept in agriculture. The law has limitations, however. For example, if several nutrients are in low supply but none is very low, an increase in any of them boosts plant growth.

Liebig also studied the biochemistry of animal nutrition, respiration, and excretion and the relationship between animal and plant biochemistry. He developed a theory of animal metabolism and presented his findings in his 1842 book *Die Their-Chemie: Oder Die organische Chemie in ihrer Anwendung auf Physiologie und Pathologie* (*Animal Chemistry: Or, Organic Chemistry in its Application to Physiology and Pathology*, 1842), one of the first syntheses of animal chemistry. Although the book contained many misconceptions, it was influential and prompted further research.

Liebig's work in animal biochemistry extended to human nutrition and food technology. He developed a concentrated beef extract. In 1866, the Liebig Extract of Meat Company was opened in Uruguay, with the goal of providing an inexpensive, nutritious meat substitute. The extract became very popular in Europe but was later shown to be of limited nutritional value. Liebig also developed a formula for infants.

SIGNIFICANCE

Although many of Liebig's statements proved wrong, he pioneered in using a chemical approach to understanding plant and animal biology. He described the great chemical cycles in nature and led the way in applying chemistry to agriculture, food, and nutrition. His idea of the usefulness of artificial fertilizers was, in the main, correct. His book on agricultural chemistry not only helped clarify existing knowledge of plant nutrition but also marked the beginning of the systematic development of the agricultural sciences and launched a revolution in agricultural practice.

By the 1850's, there were at least a dozen superphosphate plants in Britain and Germany, and by 1900 world production was more than 4.5 million tons a year. Superphosphate has become one of the world's most important fertilizers. The use of fertilizers has helped support a growing population. As of the early twenty-first century, nitrogen-containing fertilizers were important in feeding about 40 percent of the world's people. Use of fertilizers has also led to environmental problems, however. Nitrogen-laden runoff from fertilized agricultural fields pollutes surface waters. Further, production of nitrogenous fertilizers consumes large amounts of fossil fuels.

Jane F. Hill

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■ 1845-1854

POTATO CROP FAILURES CAUSE GREAT IRISH FAMINE

Successive potato crop failures caused nearly a decade-long famine that resulted in untold deaths, prompted mass emigration to North America, and helped to induce the emergence of independence movements and the birth of the Irish Republican Army.

LOCALE: Ireland

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Disease and health issues; Famine and hunger; International food relief; Migration

KEY FIGURES

Sir Robert Peel (1788-1850), Conservative British prime minister, 1841-1846, and chief secretary for Ireland

Lord John Russell (1792-1878), Liberal British prime minister, 1842-1852, who worked to alleviate the Irish famine

Charles Edward Trevelyan (1807-1886), financial secretary to the Treasury, who sought to make Ireland financially self-sufficient

William Smith O'Brien (1803-1864), leader of the Young Ireland Party who organized the Tipperary Insurrection

Daniel O'Connell (1775-1847), moderate Irish nationalist leader who advocated peaceful means of change

SUMMARY OF EVENT

Irish peasants long depended upon the potato as their major source of subsistence. A high caloric crop, the potato provided a monotonous diet but was more nutritious than many diets of advanced countries of Europe. From 1750 to 1845, Ireland experienced a few famines but none as devastating as the Great Famine of 1845-1850. As early as 1728, the scarcity of food had led to a revolt in County Cork, and total crop failures in 1739 and 1740 had caused the death of some three hundred thousand people. However, Irish violence rarely took the form of food riots.

It has been estimated that only 47 percent of Irish potato crops were directly consumed by humans; the rest were exported or fed to animals. Earlier potato failures and famines at the beginning of the nineteenth century had led some people in Ireland to believe that the country's political and economic fusion with Great Britain, under the Act of Union of 1801, might prove advantageous, especially with the establishment of free trade between them. However, any hopes that the Irish had regarding free trade with Great Britain were soon dashed. The British simply used Ireland as a place to dump surplus goods.

In contrast to Britain, Ireland did not industrialize. Those out of work joined a growing agricultural labor force unable to find steady employment in the countryside. The major reason for unemployment, which by 1845 stood at three-fourths of the labor force, was Ireland's soaring population. The average Irish country family spent two-thirds of its income on food. It is estimated that the population increase between 1779 and 1841 amounted to 172 percent, of which six-sevenths was rural in 1841. Given the decline of native industry, Irish workers who did not wish to emigrate had no choice but to return to the land and a declining agrarian economy.

The worse abuses in Irish life prevailed in the rural districts. The uncertainty of land tenure was a constant grievance of all classes of tenants, but even more aggravating were the absentee landlords, both Irish and British, some of whom never set foot in Ireland. Many of these landlords ran their estates through ruthless agents, who charged exorbitant rents and refused to compensate the peasants for improvements they made. Peasants who complained about these practices almost invariably found themselves evicted from their crofts—small farms that were often less than one acre in size—with little hope of legal redress.

Between 1842 and 1849, as many as 58,423 peasants were evicted from their crofts. Under the Irish land tenure system, born of centuries of successive conquests, rebellions, and confiscations, landlords, or their agents, often paid the peasants no wages. The peasants usually worked off the rents on their potato patches with their labor, to which the landlords assigned wage values. The rents were sufficiently low that the peasants seldom saw any coin of the realm; in fact, many of them did not even understand the proper use of money.

Most Irish peasants worked for potatoes, which for them were the real medium of exchange. On the other hand, more prosperous peasants paid their rents in money realized, in part, from the sale of pigs and potatoes. According to the Devon Commission, organized in 1843 to investigate rural conditions in Ireland, the principal cause of Irish misery was, not surprisingly, the bad relations between landlords and tenants. In fact, Roman Catholic peasants were allowed to hold their land leases for no more than thirty-one years.

However, the main source of distress for the Irish peasants was their appallingly low standard of living, increasing population, and their logistical and legal inability to improve their economic base. Most peasants lived in windowless, one-room, mud cabins, which they frequently shared with their pigs. Many of the unemployed installed makeshift roofs over ditches or eked out their existences in ill-drained bog holes. These ghastly conditions, which eventually inspired the moderate Irish nationalist leader Daniel O'Connell to work for the repeal of the Act of Union of 1801, did not prevent the Irish masses from barely surviving as long as they could grow and consume their potatoes.

Initiated by the potato crop failure of late 1845, the Great Irish Famine lasted into 1848 because of successive crop failures. The failures of this period manifested themselves in the form of a blight, a condition hitherto unknown in Ireland. Previous crop failures had been caused by frost, dry rot, and curl. It is now known that the blights of the late 1840's were caused by the fungus *Phytophthora infestans*, a microscopic organism that was probably introduced by a ship from North America, where outbreaks of potato blight had occurred in 1842. Borne by the wind, the fungus spores invaded the potato plant, germinated, and reproduced rapidly, aided by the warm, humid weather that prevailed in Ireland in 1846. That year's crop was planted with the slightly diseased seed potatoes of the year before. In the absence of modern chemical treatments, that situation resulted in the total loss of the 1846 crop.

Some landlords compounded the suffering by forcibly evicting tenants who could not pay their rents. Other landowners, seeking to recover their financial losses, converted their estates to grazing farms or planted other crops, particularly grain, for which they no longer needed potato peasants. Countless peasants who did not starve to



"Famine field" in western Ireland on which lined ridges of mid-nineteenth century failed potato crops can still be seen. (©Jmci/Dreamstime.com)

death in the bitter winter of 1846-1847 succumbed during 1847-1849 to near-endemic conditions of dysentery, scurvy, and dropsy, caused by starvation diets and deplorable sanitation and hygiene. Typhus and relapsing fever reached epidemic proportions in 1847, and cholera broke out in 1849. Of the seven hundred thousand or more deaths during that period, it has been estimated that most were the result of disease rather than starvation. The small relief that the generally good potato crop of 1847 brought to the country was canceled out by the widespread failure of the 1848 crop. Ireland needed substantial aid from outside.

Some help had come from Great Britain and other quarters since the end of 1845. In November of 1845, Sir Robert Peel, the Conservative British prime minister, established the Relief Commission for Ireland and organized a program of relief in four phases. The first and most important step was the organization of local efforts in which Peel instructed the Relief Commission to form local committees of sympathetic landowners, or their agents, clergy, magistrates, and their leading residents. These committees were to raise money for the purchase of food, which was then to be resold or given

to the needy. Landlords were to employ more workers on their estates.

The second phase of the plan called for the Irish Board of Works to create extra employment by building new roads, a traditional undertaking for the provision of famine relief. Third, in expectation of the outbreak of pestilence, or “fever” as it was called, arrangements were to be made for the care of the sick, either in special fever hospitals and private homes or in separate buildings on the grounds of workhouses. Finally, Peel placed an order in America for one million pounds of Indian corn. To facilitate subsequent importation of foreign grain, Peel worked for the repeal of Britain’s Corn Laws, which placed high tariffs on grain imports. His effort was crowned with success in early June, 1846, but the repeal issue contributed to his fall from power before the month ended.

In June of 1846, a Liberal ministry under Lord John Russell brought substantial changes in the British government’s policy toward the problem of Irish relief. Virtually in control of Irish relief by that time was Charles Edward Trevelyan, financial secretary to the Treasury and staunch proponent of *laissez-faire*, which was the living embodiment of classical English liberalism. Trevelyan believed that it was necessary to terminate future importation of grain by the government to feed the Irish people. Otherwise, in his view, they would become totally dependent upon the government for their needs, an idea abhorrent to mid-nineteenth century liberals. The government, moreover, should no longer lend its financial support to the maintenance of public work projects; ideally the projects should be largely suspended.

Trevelyan thus rejected two essentials of Peel’s relief program: foreign grain and public works. He was obliged, however, because of worsening conditions in Ireland, to place new orders for corn in the United States, which that country found difficult to fill because of heavy buying by other European states. In the second part of his scheme, the elimination of public works, Trevelyan was eventually successful. The public works experiment had not gone well. Many Irish workers did not know how to handle money they received. Many more were too ill from hunger and disease to work properly, if at all, and the roads, piers, and canals they built rapidly fell apart. Indeed, the Board of Works that directed these projects was described as

“wholesale destroyers of her Majesty’s highways.” Hence, early in 1847, Russell’s cabinet phased out the public works program and in its place introduced government soup kitchens to supplement those already being run by the Roman Catholic Church, the Quakers, and others.

The government believed that distributing free soup, a popular philanthropic activity, would be cheaper to finance than other measures and would have the greatest effect in alleviating hunger. However, it was not long before the British government received complaints that the soup, because of its components, was having an adverse effect upon the sickly constitutions of its recipients. Also, some Irish, for religious reasons, resented being served soup on Fridays. In one incident, an Irish peasant walked thirteen miles to obtain his family’s ration of meal. When he arrived at the depot, the English were serving meat soup to the hungry. Since it was a Friday and he was a staunch Catholic, he refused to accept the soup and returned home with the family’s ration. By June of 1847, Parliament took steps to streamline the relief through the passage of the Irish Poor Law. Two months earlier, Parliament had enacted the Irish Fever Bill to provide care for thousands of people afflicted by disease.

SIGNIFICANCE

The Great Famine greatly reduced the population of Ireland. Approximately 700,000 to 1,000,000 people died between 1846 and 1854, and nearly 1.75 million people emigrated. About three-quarters of the emigrants went to the United States, but thousands of them died there from disease, and countless others died while crossing the Atlantic in cramped, dirty ships fit only for livestock. An 1851 census placed Ireland’s population at slightly more than 6.5 million people, 1.5 million fewer than ten years earlier. Allowing for a normal rate of increase if the famine had not occurred, the net decline was about 2.5 million people.

Two other results of the famine are noteworthy. To help landlords financially ruined by the disaster, which had spelled death for the peasants, Parliament passed the Encumbered Estates Act of 1849 that provided for the sale of estates of ruined owners. Under this law, many estates passed into the hands of new landlords, some of them

English and Scottish. Many new landlords who wished to improve their holdings evicted their tenants or treated them even more harshly than their predecessors.

Politically, the famine gave prominence to the militant Young Ireland Party which, under the leadership of William Smith O'Brien and others, rejected O'Connell's peaceful methods of securing home rule in place of the Act of Union of 1801. The Young Irishmen were especially embittered over the fact that during the height of the famine, the British government was continuing to import large amounts of grain from Ireland. Inspired by the outbreak of the continental revolutions of 1848, O'Brien precipitated the Tipperary Insurrection in July of that year in the vain hope that Irish peasants would rise up to support him. The local constabulary put



As this 1880 cover of the popular magazine Harper's Weekly shows, the problem of insufficient food continued to afflict Ireland several decades after the midcentury potato crop failures.
(Library of Congress)

down the uprising and captured O'Brien. After O'Brien was deported to Australia, the Young Ireland Party died.

Edward P. Keleher, updated by John Alan Ross

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1845-1854

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■ JUNE 15, 1846

BRITAIN'S REPEAL OF CORN LAWS REDUCES POWER OF LANDOWNERS

The repeal of the Corn Laws, tariffs on imported grain intended to protect farmers and landowners from cheaper imports, reduced the economic power of the aristocracy, complementing their loss of political power as a result of the Reform Act of 1832.

LOCALE: England

AGRICULTURAL ISSUES: Agrarian reform; Government policy and regulation; Marketing and trade

KEY FIGURES

John Bright (1811-1889), Lancashire manufacturer and Radical member of Parliament

Richard Cobden (1804-1865), Manchester businessman and member of Parliament

Sir Robert Peel (1788-1850), Tory prime minister, 1841-1846

John Russell (1792-1878), Whig leader and later prime minister, 1846-1852, 1865-1866

SUMMARY OF EVENT

Great Britain's Corn Laws imposed tariffs on imports of grains, which are collectively called "corn" in Great Britain. The laws had existed for several centuries and had been revised a number of times, most recently in 1828. The Corn Law Act of 1828 had established a sliding scale with the duty on grain rising as the selling price of English grain decreased, in order to keep grain prices high enough to ensure a profit for farmers and, especially, large landowners. These groups believed that their prosperity and the continuation of English agriculture depended on maintaining high import duties. Most of the leaders of both the Tory and Whig parties were large landowners and usually supported the Corn Laws.

Among economists, however, the great majority, especially those belonging to the predominant classical liberal school of thought,

JUNE 15, 1846

sometimes called the Manchester School, strongly condemned the Corn Laws. The Corn Law controversy was linked to the whole question of free trade versus protectionism. Adam Smith had advocated free trade as early as 1776, and David Ricardo had specifically applied such doctrines to agricultural protection some fifty years later. He contended that the Corn Laws raised food prices, protected inefficient farmers, and hurt Great Britain's foreign trade by making it impossible for countries with agricultural surpluses to trade those surpluses for British manufactured goods.

Industrialists, businessmen, and middle-class radicals generally opposed the Corn Laws, while the working classes were badly split in their attitude toward them. Many leaders of the working classes feared that if food became cheaper, the industrialists would only use it as an excuse to lower wages.

In the comparatively prosperous times up to 1837, there was little interest in the Corn Law question. There was a gradual increase in anti-Corn Law literature, and an Anti-Corn Law League was founded in London in 1836, but the effects of both were limited. The depression of 1837 and the subsequent hard times, however, combined with a rise in food prices to give impetus to anti-Corn Law agitation.

The Anti-Corn Law Association of Manchester was founded in September, 1838, and soon gained considerable support from Manchester industrialists, enabling it to raise large sums of money to support a campaign against the Corn Laws. Prominent among the early leaders was Richard Cobden, a Manchester industrialist and a strong supporter of free trade, who was both an effective organizer and a compelling speaker. He was soon joined in leadership of the Anti-Corn Law Association by John Bright, another industrialist and also a persuasive speaker. The Manchester Association sent out lecturers who held large mass meetings and succeeded in causing the formation of other Anti-Corn Law associations in various industrial cities in the north.

The first attempts to move the abolition of the Corn Laws were decisively defeated in Parliament. Although a motion to terminate the Corn Laws secured 172 votes in February, 1839, when it was introduced, the combined opposition of the Whig government of Lord Melbourne and the Tory opposition doomed the effort.

This defeat spurred the anti-Corn Law groups to form a single

centralized organization, the Anti-Corn Law League, with headquarters in Manchester. A paper, *The Anti-Corn Law Circular*, began publication in April and a large meeting hall was erected. The money for this was obtained by membership subscriptions of five shillings a year and large gifts from industrialists. A regular system of traveling lecturers was set up and millions of pamphlets were distributed as the league gradually became a well-financed, effective propaganda machine on a scale hitherto unknown in British politics.

The league publicly argued its cause not on the particular advantages to manufacturers, but on a more general and moral plane. Cobden contended that repeal would lower food prices for the poor, that by increasing trade it would aid general prosperity throughout Great Britain and the world and thus would aid world harmony, and that it would make British agriculture more efficient by competition.

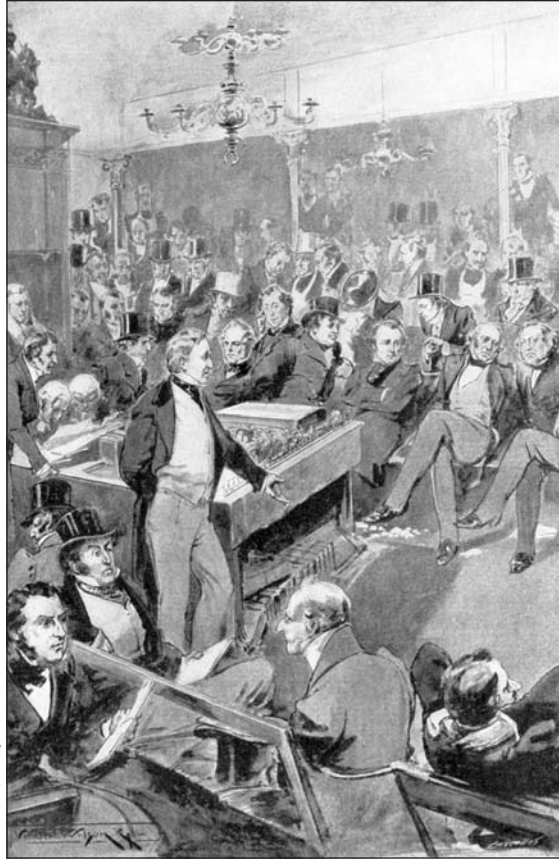
The league hoped to obtain the support of the working classes, but their leaders, heavily involved in the Chartist movement to broaden the franchise, opposed the idea of repeal, arguing that it would only enable manufacturers to reduce wages, and that it would take away the livelihood of agricultural workers. Chartists often broke up league meetings by violence and greatly hindered the league's activities.

Under pressure from the Whig-liberal leader Lord John Russell in 1841, the Whig government decided to lower tariffs and set a low fixed duty on corn. Even though some of the league's members who had seats in Parliament supported this measure, the league as a whole opposed it. In the end, nothing came of the plan except that it caused the fall of the Whig government, leading to new elections won by Tory protectionists.

Although he favored retaining some protection for grains, Sir Robert Peel, the new Tory prime minister, hoped to defuse the issue by introducing a general overhaul of the tariff. These measures did not satisfy the league, and its orators began to speak of violence and revolution. Some employers even encouraged strikes and revolutionary unrest among their employees to pressure Parliament. These tactics failed, however, and the league returned to more peaceful efforts, focusing on propaganda and large public meetings.

Finally, in 1846, prospects for repeal suddenly improved. Several years of good harvests were followed by an extremely wet growing sea-

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*Sir Robert Peel
introducing free trade
laws in Parliament.*
(Francis R. Niglutsch)

son; above all, the potato harvest in Ireland failed almost entirely. In the face of this situation and Cobden's exploitation of it in debates in Parliament, Peel became convinced of the need for immediate repeal of the Corn Laws. Russell, then the Whig leader, had come out for immediate repeal.

Peel's first attempts to persuade his cabinet to suspend the Corn Laws caused his ministry to break up. However, Russell, the leader of the opposition, proved unable to form a government, and Peel returned with a reconstructed cabinet. When Peel proposed a drastic reduction in the duties on foreign grain, to lead, three years later, to total repeal, a large section of his own party revolted against him and the other party leaders. Peel argued that economic necessity in the face of famine and the political need to prevent a clash between the

middle classes and the aristocracy forced his hand. Russell and many Whig-liberals had become free traders and supported Peel, as did most of the conservative leaders, although the latter did so reluctantly. In the successful repeal vote in the House of Commons on May 15, 1846, a majority of the Tory members voted against the government. The duke of Wellington then carried the repeal through the House of Lords on June 15.

Peel was defeated shortly afterward on an Irish measure by a combination of liberals and protectionist Tories, and he resigned. The issue of the Corn Laws split the Tory Party, Peel's followers being known as Peelites, while the protectionist Tories reformed as the Conservative Party under the leadership of Benjamin Disraeli.

SIGNIFICANCE

Corn Law repeal helped push along the reorganization of British political parties from aristocratic factions into modern political organizations dependent on the support of voters. The Anti-Corn Law League served as a prototype of modern political pressure groups in both its organization and its propaganda.

Corn Law repeal was the first step in the conversion of British tariff policy to one of free trade instead of protectionism. The policy persisted as dogma for more than eighty years.

James H. Steinel, updated by Nancy M. Gordon

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■ MARCH 3, 1861

SERF EMANCIPATION BEGINS RUSSIAN AGRICULTURE MODERNIZATION

The emancipation of Russia's serfs fundamentally altered the political, social, and economic relationships that had upheld the czarist system through more than two centuries but did not satisfy rising pressures for fundamental reforms.

LOCALE: Russia

AGRICULTURAL ISSUES: Agrarian reform; Feudalistic systems; Government policy and regulation; Labor; Slavery

KEY FIGURES

Alexander II (1818-1881), czar of Russia, r. 1855-1881

Nikolai Miliutin (fl. mid-nineteenth century), principal author of the emancipation legislation

Philaret (Vasily Mikhaylovich Drozdov; 1783-1867), metropolitan patriarch of Moscow who coauthored the emancipation decree

Nikolay Chernyshevsky (1828-1889), radical journalist

Yuri Samarin (1819-1876), coauthor of the emancipation decree

Helena Pavlovna (Grand Duchess of Russia; 1807-1873), liberal reform-minded widow who worked for the emancipation of the serfs

Aleksandr Herzen (1812-1870), radical journalist

SUMMARY OF EVENT

Serfdom developed in Russia as an integral part of the Russian political system. Medieval European notions of serfdom held that peasants belonged to the land. Thus, when title to land changed hands, the peasants went with it. In Russia, however, serfdom was virtually indistinguishable from slavery because the peasants could be legally separated from the land. By law and by custom, landowners held powers over peasants that made them chattel. Peasants discharged their formal obligations either by paying cash (*obrok*) or by giving their owners stipulated amounts of work (*barshchina*). The owners, in turn, were expected to maintain the peasants during famine times, to watch over their health and welfare, and in all ways to act as fathers to them.

MARCH 3, 1861

In practice, these conditions meant that landowners held the power of life and death over their serfs, for whom there was neither recourse nor protection against abuses.

Serfdom developed into the foundation of the Russian economy. Between 1649 and the mid-nineteenth century, the government preserved the principle of serfdom, although the institution did not go entirely unchallenged. A growing chorus of criticism developed as enlightened landlords and bureaucrats joined the new intellectual classes in condemning serfdom as the most stultifying and barbarous influence in what had become a stagnant country.

As Russia entered the nineteenth century, the inadequacy of serfdom to meet the needs of a developing industrial society was clearly demonstrated. Even Czar Nicholas I, whose concept of official nationality made serfdom an essential element in the autocratic order, established several commissions to study the peasant problem, and he also made it easier for individual landlords to release serfs from bondage. His son and successor, Alexander II, benefited from the demand for reform that followed Russia's defeat in the Crimean War, and he began his reign by announcing that he intended to change Russia from above in order to avoid change from below.

Alexander II was a conservative who saw that it was necessary to reform the autocracy in order to preserve it. Although only thirty-seven years old at the time of his accession in 1855, he had had wide experience in government and had already decided on the need for emancipation. In 1856, he invited the gentry to formulate reform proposals. In January of 1857, a private committee was formed to pursue the question. The committee was chaired by the reactionary Prince Aleksei Orlov, but other more enlightened persons pressed for progress. These included the Grand Duke Constantine Nikolaevich and the Grand Duchess Helena Pavlovna, as well as Count P. D. Kiselev, Nikolai Miliutin, Count Yakov Rostovtsev, and Count Sergei Lanskoi, the minister of the interior. Rostovtsev headed the Editing Commission, which was responsible for working out the details of the emancipation legislation, and Miliutin became the chief author of the emancipation legislation. While the government deliberated, liberal and radical journalists, including Aleksandr Herzen in London and Nikolai Chernyshevsky in St. Petersburg, urged action and for a brief period conservatives and radicals seemed united in bringing a new era into being.

Three years of intensive work produced the emancipation decree, which was drafted by Yuri Samarin and Philaret, the metropolitan patriarch of Moscow. The decree was signed on March 3, 1861 (February 19, according to the Julian calendar then used in Russia). Two

ALEXANDER II ON SERF EMANCIPATION

Czar Alexander II addressed the Russian state council in early 1861, imploring, in the excerpt here, that the council abolish serfdom for the good of the country.

The matter of the liberation of the serfs, . . . I consider to be a vital question for Russia, upon which will depend the development of her strength and power. . . .

For four years now it has dragged on and has been arousing fears and anticipations among both the estate owners and the peasants. Any further delay could be disastrous to the state. . . .

Before proceeding to a detailed examination of this draft itself, I would like to trace briefly the historical background of this affair. You are acquainted with the origin of serfdom. Formerly it did not exist among us; this law was established by autocratic power and only autocratic power can abolish it, and that is my sincere will.

My predecessors felt all the evils of serfdom and continually endeavored, if not to destroy it completely, to work toward the gradual limitation of the arbitrary power of the estate owners. . . .

There may be various views on the draft presented, and I am willing to listen to all the different opinions. But I have the right to demand one thing from you: that you, putting aside all personal interests, act not like estate owners but like imperial statesmen invested with my trust.

Source: "Address in the State Council" (1861), in Sources of the Making of the West: Peoples and Cultures, edited by Katharine J. Lualdi (Boston: Bedford/St. Martin's Press, 2001), vol. 2, pp. 91-92.



(Library of Congress)

MARCH 3, 1861



After the emancipation of Russia's serfs, peasant farmers could no longer depend on big landowners for support during famine years. This picture from an 1892 issue of the Illustrated London News shows peasant families heading for St. Petersburg after abandoning their failed farms. (Library of Congress)

weeks later it was read out in all the churches of Russia. Serfdom was officially abolished. The decree destroyed the power of landlords over the peasants and made the *mir*, or commune, the basic unit with which the government dealt. The gentry retained something more than half of the arable land, and the peasant communes divided the remainder among their members.

The gentry were paid immediately by the government for the land that they gave up, while the peasants were committed to "redemption payments" to the government for forty-nine years. The amount of land assigned to the peasant communes varied from province to province, but in no case was it equivalent to the land the peasants had worked under serfdom. Individual peasants, however, were granted the right to contract leaseholds, and they could also work as laborers. In this way, it was possible to make up a portion of the deficit which the smaller allotments created.

Flaws in the emancipation scheme proved to be only too obvious.

Peasants, though freed from their former landlords' control, were still not considered legal beings, as communes were interposed between them and society. The government, which relied on the communes to take the place of serf owners in keeping order in the countryside, thus replaced bondage to landlords with bondage to communes. The former serfs were not free to sell their allotments or even seek work outside their villages without the permission of their communes. Since members of communes were jointly responsible for making redemption payments and paying taxes, the communes were typically reluctant to grant individual peasants permission to leave, lest financial burdens increase for those who remained behind.

SIGNIFICANCE

When it became clear that Alexander II had not instituted the peasant reform as the first step toward liquidating the autocracy, and as the conservative character of the peasant reform became clearer, a new generation of Russian radicals turned their back on government-sponsored reforms. They opened new attacks on the czar and began to organize political circles for action. The liberal minds of the 1830's and 1840's found themselves out of touch with the new radical generation, and even the venerated Herzen was distressed to discover that he had been bypassed, if not forgotten. Emancipation was only a milestone on Russia's road to modernity, not the end of the journey as many hoped in 1861.

Russell M. Magnaghi, updated by Richard D. King

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■ MAY 20, 1862

HOMESTEAD ACT OPENS WESTERN LANDS TO FARMERS

Passed by the U.S. Congress in response to the growing demand for land in the West, the Homestead Act greatly stimulated settlement of vast territories by making it possible for thousands of families to obtain land for free.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Agrarian reform; Government policy and regulation; Land and land policy; Migration; Population growth

KEY FIGURES

Thomas Hart Benton (1782-1858), Democratic senator from Missouri who advocated for homestead legislation

George H. Evans (1805-1856), New York labor leader who advocated a liberal land policy

Horace Greeley (1811-1872), editor of the *New York Tribune* who supported homestead legislation

Andrew Johnson (1808-1875), Democratic senator from Tennessee who led the fight for homestead legislation

Abraham Lincoln (1809-1865), president of the United States, 1861-1865

SUMMARY OF EVENT

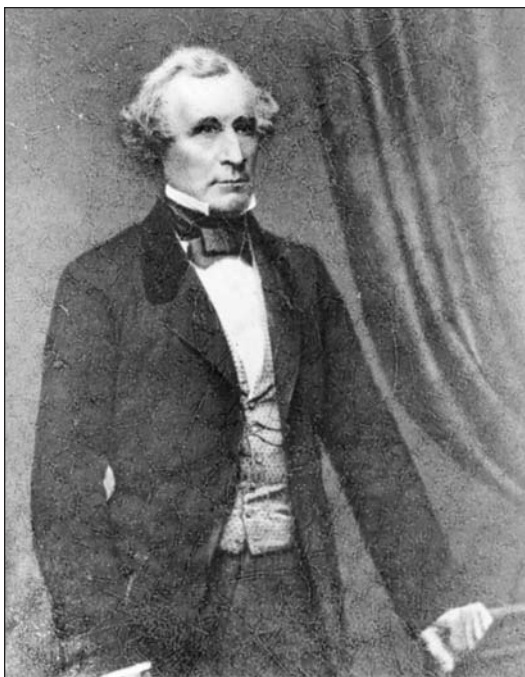
The United States grew enormously between 1840 and 1860, and reached its full continental limits in 1854, through the acquisition of Mexican territory ceded in the Treaty of Guadalupe Hidalgo (1848) and the Gadsden Purchase (1853). At the same time, its population continued its upward spiral, rising from slightly more than seventeen million people in 1840 to more than thirty million in 1860. Meanwhile, new canals, steamboat companies, turnpikes, and railroads were knotting the nation together into an integrated economic unit. Hundreds of thousands of Europeans crossed the Atlantic to take up residence in the dynamic new nation, while other hundreds of thousands moved into the western regions of the country.

The growth of the West was especially marked. While the population of all sections grew, the North and the South experienced less relative growth during these two decades than did the West. As the West approached a position of equality with the older sections, it became more insistent in its demands upon the federal government. At the same time, the intensification of sectional antagonisms engendered by the controversy over slavery and its future in the nation fatally obstructed efforts at the national level to provide guidelines and incentives for growth.

By 1840, sectional lines had hardened. Southern majorities in Congress consistently blocked legislation introduced by legislators from the other sections of the country. This was true in debates over tariffs, internal improvements, central banking, and land policy. However, the West won a significant victory in the congressional debate over the disposition of the public domain with the passage of the Preemption Act of 1841, which gave squatters the right to purchase up to 160 acres of land that they had settled and improved for only \$1.25 per acre. The next logical step for westerners was for the government to provide completely free land as an incentive to settle and develop new territories.

The campaign to achieve free land was waged on two fronts. Westerners, such as Missouri senator Thomas Hart Benton, consistently pushed for free-land legislation and were joined by increasing numbers of other westerners committed to the free-soil idea. The slavery controversy erupted vigorously during the Mexican War, with efforts by free-soil Whigs to pass the Wilmot Proviso, which would have permanently forbidden slavery in the new lands conquered from Mexico.

It was obvious that the idea of free homesteads would work to the advantage of free-soil groups by attracting into the newly won territories settlers from the North, who, being slaveless, were more mobile. Therefore, the Free-Soil Party made homestead legislation part of its platform for the 1848 campaign. By the 1850's, most northerners accepted the idea that the western land should be settled as rapidly as possible in order to bring it into production and to provide a stable population that would serve as a market for the industrial centers in the East. The eastern-based land reform movement, led by George H. Evans and supported by Horace Greeley and his *New York Tribune*, rounded out the alliance.



Senator Thomas Hart Benton.
(Library of Congress)

A struggle for homestead legislation was waged in Congress through the 1850's. The congressional sessions of 1851, 1852, and 1854 devoted much time to such proposals. Southerners were opposed to the concept and argued that no benefits would accrue to their section. In spite of the leadership of Andrew Johnson of Tennessee, the Senate, dominated by the southern wing of the Democratic Party, managed to block passage of several bills that passed the House of Representatives. When the Senate finally did pass a homestead bill in 1860, it was vetoed by President James Buchanan. The Republican Party committed itself to this policy and incorporated a homestead plank in its platform of 1860.

The election of Republican Abraham Lincoln in 1860 did not guarantee the passage of homestead legislation, because the South still controlled the Senate. However, the secession of the southern states finally made passage of the legislation possible. During the special session of Congress in 1861, a bill was introduced into the House and passed in February, 1862. It passed the Senate in May and was signed by President Lincoln on May 20.

Under the provisions of the bill, which was to go into effect January 1, 1863, settlers twenty-one years of age or older who were, or intended to become, citizens and who acted as the heads of households could acquire tracts of 160 acres of surveyed public land free of all but ten-dollar registration payments. Titles to the land went to the settlers after five years of continuous residence. Alternatively, after only six months, the claimants could purchase the land for \$1.25 per acre. Over the years, amendments and extensions of the act made it applicable to forest land and grazing land and enlarged the maximum acreage tract that individual settlers could acquire.

In 1873, the Timber Culture Act adjusted the original act so that in arid western regions homesteaders could obtain 160 additional acres on which they would agree to plant at least forty acres—a figure later reduced to ten acres—of trees. The Desert Land Act of 1877 allowed

HOMESTEADER QUALIFICATIONS

The first section of the Homestead Act of 1862 spelled out the qualifications for claiming land.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any person who is the head of a family, or who has arrived at the age of twenty-one years, and is a citizen of the United States, or who shall have filed his declaration of intention to become such, as required by the naturalization laws of the United States, and who has never borne arms against the United States Government or given aid and comfort to its enemies, shall, from and after the first January, eighteen hundred and sixty-three, be entitled to enter one quarter section or a less quantity of unappropriated public lands, upon which said person may have filed a preemption claim, or which may at the time the application is made, be subject to preemption at one dollar and twenty-five cents, or less, per acre; or eighty acres or less of such unappropriated lands, at two dollars and fifty cents per acre, to be located in a body, in conformity to the legal subdivisions of the public lands, and after the same shall have been surveyed: Provided, That any person owning and residing on land may, under the provisions of this act, enter other land lying contiguous to his or her said land, which shall not, with the land so already owned and occupied, exceed in the aggregate one hundred and sixty acres.

western ranchers to homestead up to one square mile, or 640 acres, of ranch land in certain areas. During the 1930's, executive decisions by President Franklin D. Roosevelt and the Taylor Grazing Act withdrew the remainder of the public domain from private entry. By then, 285 million acres had been homesteaded in the United States.

SIGNIFICANCE

The Homestead Act was not the complete success its supporters hoped it would be. Homesteading never proved attractive to members of the working class and the urban poor in the East. There also were many competing forms of federal land distribution, including purchase by speculators, massive land grants to railroads, sales of dispossessed Native American lands, and Morrill Act lands turned over to states for sale to support public education. Altogether, more than 80 percent of public lands were distributed through means other than homesteading. Moreover, fewer than half of the nearly three million homesteaders who filed claims actually "proved up" and acquired title to their land after five years. The so-called "Southern" Homestead Act of 1866, which was designed to provide land to former slaves, was especially disappointing. Never effectively implemented, it was strenuously opposed by southern whites. Nevertheless, despite their failings, the Homestead Acts helped several million families to obtain land and settle in the West, and it became an important symbol of the effort to create an egalitarian, middle-class, agrarian society in the United States during the nineteenth century.

John G. Clark, updated by Kent Blaser

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SEE ALSO: July 2, 1862: Morrill Land Grant Act Promotes Agricultural Education; c. 1871-1883: American Buffalo Slaughter Drives Indians to Farming; 1872: Canada's Dominion Lands Act Attracts New Immigrant Farmers; 1874: Barbed Wire Fencing Transforms American Ranching; 1879: Powell Recommends Water Management Schemes for Western Agriculture; 1896: Immigrant Farmers Begin Settling Western Canada.

■ JULY 2, 1862

MORRILL LAND GRANT ACT PROMOTES AGRICULTURAL EDUCATION

Under the terms of this law, the federal government granted land to states for the establishment of agricultural and engineering colleges, thereby setting the stage for a revolutionary extension of higher education to the masses.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Agricultural education; Government policy and regulation; Land and land policy

KEY FIGURES

James Buchanan (1791-1868), president of the United States, 1857-1861

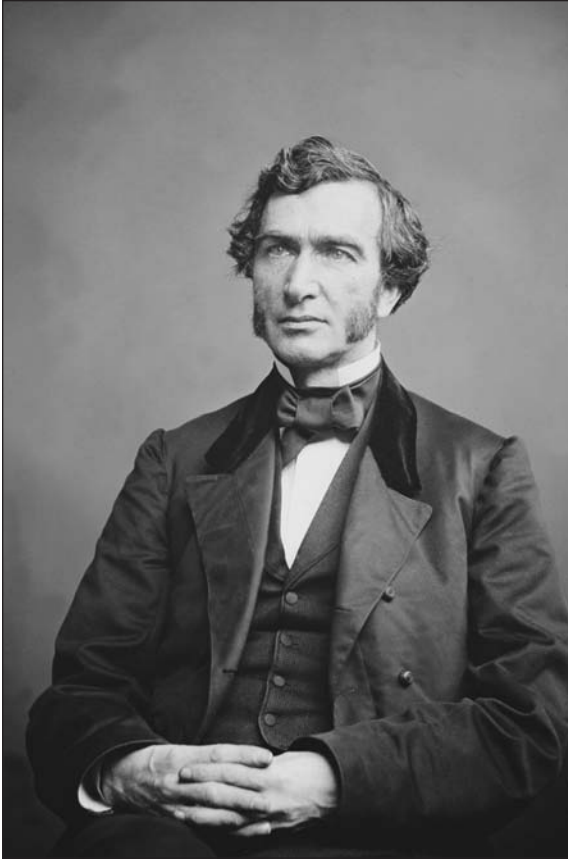
Abraham Lincoln (1809-1865), president of the United States, 1861-1865

Justin Smith Morrill (1810-1898), congressman and senator from Vermont

SUMMARY OF EVENT

Justin Smith Morrill, the author and successful promoter of the Morrill Land Grant Act of 1862, was a Vermont congressman who was first elected to national office in 1854 as a Whig. With the subsequent demise of that party, Morrill helped to found the Republican Party in Vermont. In the U.S. House of Representatives, he served on both the Committee on Territories and the Committee on Agriculture and became chairman of the powerful Ways and Means Committee in 1861. After he was elected to the Senate in 1862, he served there until his death in 1898.

Several attempts to use land revenues to aid the promotion of public education had been made before Morrill introduced his bill. For example, the Ordinance of 1785 provided that the sixteenth section in each township was to be set aside for educational purposes. In 1848, when the Oregon Territory was organized, section 36 was added to section 16 in each township for common schools. The Pre-



*Justin Smith Morrill
around the time his Land
Grant Act was passed.
(Library of Congress)*

emption Act of 1841 (known also as the Distribution-Preemption Act) turned over to the states, for internal improvements, one-half million acres. Wisconsin, Alabama, Iowa, and Oregon used the proceeds from the sale of these lands for public schools. Revenues from the Swamp Lands Acts of 1849 and 1850 were applied in many states for the purpose of common education. Beginning as early as the 1840's, a movement in the northeastern states made progress toward the establishment of agricultural colleges. During the 1850's, several states petitioned Congress for land to be used for educational purposes.

Morrill was interested in both education and agriculture. He regretted the fact that most existing institutions of higher education taught on the classical plan, giving farmers, mechanics, and others

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employed at manual labor no opportunities for scientific training and leaving most of them doomed to the haphazard methods of self-education. In 1856, Morrill introduced a resolution that the Committee on Agriculture investigate the possibility of establishing at least one agricultural school that would be patterned after the military academies at West Point and Annapolis.

Morrill's 1856 resolution was not acted upon, but in 1857, he introduced a bill that would donate public lands to the states for the purpose of creating colleges to train students in agricultural and mechanical arts. The land was to be apportioned to each state at a rate of twenty thousand acres for each senator and representative the state had in Congress, and sixty thousand acres to each territory. Proceeds from sales of this land were to be used in the states as perpetual funds, the interest from which was to be appropriated to the support of colleges. Within a period of five years after the passage of the bill, states accepting the public lands were required to have established colleges. If sufficient land for such grants were not available in any state, that state was to receive an equivalent amount of land scrip that could be used to purchase land elsewhere. This scrip had to be sold to private individuals, who could then choose holdings in the unoccupied areas of any public-land state according to the amount of scrip purchased.

After Morrill's bill was presented to both houses of Congress, much opposition appeared. The South argued that the proposal was inexpedient and unconstitutional, and many of the western states believed that since the grants were to be made on the basis of population, it differed little from an unsatisfactory distribution scheme that had been proposed earlier by Henry Clay. Many congressmen from states with large land holdings attacked the bill on the grounds that large quantities of land scrip would have to be issued to the older eastern states that had little or no public domain, and the scrip soon would be acquired by land speculators who would claim large tracts of the best lands in the newer states. This land would then be held until the values had increased, and western settlement and improvement thus would be retarded. Despite these objections, Morrill's bill passed both the House and the Senate by narrow margins.

President James Buchanan then vetoed the bill. It was, he said, unconstitutional and deprived the government of the needed reve-

nue from land sales. It would make the states too dependent upon the federal government and would set up colleges in competition with existing institutions. Finally, the federal government could not compel the states to use the funds for the specified purpose if the states chose to do otherwise. A vote was quickly taken in the House to override the veto, but it failed to get the necessary two-thirds vote.

Unwilling to accept defeat, Morrill presented a second bill on December 16, 1861, after the secession of most of the southern states had changed the makeup of Congress. His new bill was almost identical to his first bill, except that it increased the number of acres to be given to the states to thirty thousand for each representative and senator. President Abraham Lincoln had previously informed Morrill that he would allow such a bill to become law. The issues were practically the same as before; however, in this instance, the representatives from the older eastern states made a determined effort to force passage of the bill. With the passage of the Homestead Act virtually assured (signed into law in May, that act granted land acreage in 160-acre lots to anyone willing to reside upon it continuously for five years), the easterners feared that their other chances to secure title to western lands were materially reduced. President Lincoln signed the Morrill bill on July 2, 1862.

The language of the Morrill Land Grant Act that Lincoln signed into law suggested a populist leaning. It provided for at least one college in each state at which studies of agriculture and the “mechanic arts” (that is, engineering) would be available to support both a liberal and practical education of what were termed the industrial classes, that is, members of the working class. Morrill no doubt was influenced by the rising democratic social climate in the United States; the growing power of workers and middle and lower managers; the importance of agriculture, industry, and commerce; and the growing body of scientific knowledge. His bill also struck a blow at the traditions of college education inherited from England and Germany that directed higher education to the preparation of well-to-do young men for careers as ministers, lawyers, scientists, college faculty, and high-level civil servants.

The concept of the land-grant college made a major contribution to extending the availability of higher education in the United

States. The colleges created under the legislation were readily supported by the states. They made possible public college-level learning at low cost and established research as a legitimate activity of higher education. As a result, agricultural and engineering arts and sciences, as professions, were elevated to positions of academic respectability.

Most of the land-grant colleges received not land but scrip, which they used to purchase public land at \$1.25 per acre. Under the terms of the act, eleven states received 1,769,440 acres of land. Public-land states later admitted to the Union received similar grants. Twenty-seven states eventually received scrip instead of land, and almost eight million scrip-acres were issued. The older states, which benefited because of their large populations, were authorized to select their acreage anywhere in the West. New York, for example, selected forest lands in Wisconsin and prairie lands scattered throughout the western Mississippi River Valley to use its 990,000-acre allotment. In all, the states received 140 million acres through the Morrill Land Grant Act and similar measures. None of this land was given to homesteads, and nearly all of it passed through the hands of speculators on its way to final users.

A second Morrill Land Grant Act was passed in 1890, stipulating that Congress was to make regular appropriations for the further support of land-grant colleges. The 1890 act resulted in the creation of seventeen agricultural and mechanical colleges in the South for African Americans. This act also established the practice of federal grants to institutions of higher education. Appropriations were increased in 1907, 1935, 1952, and 1960. By the 1960's, every state had at least one land-grant institution.

SIGNIFICANCE

Land-grant institutions have played a special role in developing several fields of study, particularly in agriculture and veterinary medicine. By the end of the twentieth century, about 75 percent of the bachelor's degrees and 98 percent of the advanced degrees in these subjects were being awarded by land-grant colleges. Engineering is another field that has been well developed in land-grant colleges, with two-fifths of all engineering degrees in the United States coming from these institutions. Almost 51 percent of degrees in home eco-

nomics are conferred by land-grant schools. A significant and little-known role is the one played by the land-grant college in military education. Thousands of officers have received their initial military training from these institutions.

Although the initial role of land-grant colleges was to teach the arts of agriculture and engineering, over the years, as additional funds and needs arose, the institutions directed some of their efforts toward research and bringing the results of that research to the users through extension offices. In many instances, the colleges must not only satisfy the needs of their traditional clientele but also serve the interests of the general public. In addition, land-grant colleges increasingly face the challenges of international competition and environmental sensitivity and awareness.

John H. DeBerry, updated by Albert C. Jensen

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SEE ALSO: May 20, 1862: Homestead Act Opens Western Lands to Farmers; 1867: Opening of Chisholm Trail Expands Cattle Markets; c. 1871-1883: American Buffalo Slaughter Drives Indians to Farming; 1872: Canada’s Dominion Lands Act Attracts New Immigrant Farmers.

■ 1867

OPENING OF CHISHOLM TRAIL EXPANDS CATTLE MARKETS

An eight-hundred-mile route from southern Texas to Abilene, Kansas, the Chisholm Trail expanded cattle markets, opened the Midwest to transport, and closed open ranges. The trail's importance began to wane with the arrival of the railroad through the region twenty years later.

LOCALE: Great Plains, United States

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Marketing and trade

KEY FIGURES

Jesse Chisholm (c. 1806-1868), Scottish-Cherokee trader and guide who pioneered the trail

John Clay (1851-1934), manager and inspector of British-owned ranch properties

Richard King (1824-1885), founder of the King Ranch in southern Texas

Joseph Geating McCoy (1837-1915), Illinois stockman who developed Abilene

Charles Russell (1864-1926), artist and chronicler of the West and ranch life

SUMMARY OF EVENT

At the end of the U.S. Civil War (1861-1865), astute and ambitious Texans conceived a plan whereby the numerous herds of longhorn cattle overrunning the southern part of the state could be rounded up and driven north to markets where they would command a higher price. Foremost among these Texans was a former steamboat captain, Richard King, whose original tract of 75,000 acres increased to 500,000 acres by the time of his death in 1885.

First introduced into California, New Mexico, and Texas by the Spaniards, the scrawny range cattle had been valuable mainly for their hides. For years, small herds had been driven every other year

from Texas to New Orleans, St. Louis, or Kansas City by many south-Texas Mexican American ranchers. New England shippers frequented Pacific coast ports to gather hides for eastern tanneries. The Civil War, however, brought many changes to this area. Railroads began pushing westward across the Great Plains; the meat-packing industry was being consolidated by a few leading packers in urban centers such as Kansas City, Omaha, and Chicago, which dominated the national market.

Joseph G. McCoy, an Illinois stockman, assumed the leadership in working out a mutually satisfactory arrangement among the cattle owners, the railroads, and the meat packers. Cattle worth five dollars a head in Texas were to be driven northward, fattened on the nutritious short grass of the public domain en route, and then delivered to the railhead for shipment to eastern markets, where they would bring forty to fifty dollars each. McCoy chose Abilene, Kansas, the terminal town on the Kansas Pacific Railroad in 1867, as the initial shipping point. McCoy ordered lumber from Missouri and built stock pens stout enough to hold three thousand restless longhorns. He placed ten-ton scales that could weigh twenty cows at a time. Besides enlarging Abilene with a livery stable, barns, and an office, he also built the Drovers' Cottage, an eight-room hotel.

The Chisholm Trail was the name given to the route by which the cattle were driven northward from southern Texas, entering the Indian Territory at Red River Crossing, and continuing into Abilene. Jesse Chisholm, a Scottish-Cherokee wagon driver, first marked this trail, which he used to trade buffalo robes with midwestern tribes. Chisholm, who never raised cattle, knew the need for grass and water on a cattle trail. In 1868, Chisholm died from eating bad bear grease, without ever completing a trip on the trail named for him. As the railroad moved farther west, alternative routes were made. The Shawnee Trail followed the route of the Chisholm Trail until it veered to Baxter Springs, Kansas. The West Chisholm Trail led into western Kansas and Ellsworth, Kansas. The Panhandle Trail fought its way across the arid mesas of western Texas. The original routes ran from the central part of Indian Territory to the railhead at Ellsworth.

The pressure of farmers taking up homesteads near the railroads forced the cattlemen to relocate their long drives ever farther to the

Opening of Chisholm Trail Expands Cattle Markets

west. Construction of the Atchison, Topeka, and Santa Fe Railroad provided a shorter drive along the Great Western Trail to southwestern Kansas, first to Newton and later to Dodge City, the recognized “cowboy capital” between 1875 and 1885. If the cattle market was overcrowded in Dodge City, some cattle owners drove their herds northward to meet the Union Pacific. After Kansas was closed to the cattle owners, ranchers developed the Goodnight-Loving Trail, which ran westward across Texas to the Pecos River country and then northward through eastern New Mexico and Colorado into Wyoming, where there was less competition.

The drives started early in the spring, immediately following the roundup. Usually a herd of twenty-five hundred to three thousand head of cattle was placed in the charge of the trail boss, who hired a dozen cowboys accompanied by a chuck wagon. The cattle were moved along the trail between ten and fifteen miles per day at a pace that would permit them to gain flesh off the rich, nutritious short grass of the Great Plains. Cowboys preferred driving the longhorns. The span of the long horns kept the cattle spaced farther apart, preventing excess body heat and flesh loss. Before leaving on a drive,



“Cowboys” got their name from the work they did managing cattle herds and driving the cattle to their markets. (Library of Congress)

owners would brand their animals, so separating them at the terminal was simplified.

Numerous dangers were encountered along the trail, including American Indian attacks, stampedes, Quantrell's Raiders, jayhawkers, swollen rivers that had to be crossed, and attacks from farmers who did not want the herds crossing their lands and spreading the dreaded Texas fever to their own stock. This fever was caused by ticks, but it was attributed mistakenly to causes ranging from thorny shrubs scratching infected animals to deliberate sabotage.

Despite these hazards, between 1868 and 1871 almost 1.5 million head of cattle were loaded on the trains in the Abilene yards. From 1872 to 1875, Newton, on the Santa Fe line, received 1.5 million animals, and Dodge shipped one million of them to the eastern markets during the succeeding four years. No business was more widely advertised and romanticized. Tales of cattle kings building large estates and herds, cowboys engaging in the roundups and long drives, law-breakers congregating in the cow towns to challenge authority and each other, and sheriffs' and marshals' attempts to maintain law and order were legion.

By 1880, the cattle industry was firmly established throughout the Great Plains. Rumors had circulated about the enormous profits that were available, with estimates running as high as a 40 percent return on capital in a single year. Investors in the East and abroad, primarily in England and Scotland, organized mammoth companies that bought acreage in New Mexico, Texas, and Colorado totaling eight thousand square miles with herds numbering more than 150,000 head.

Between 1881 and 1885, the British invested approximately \$45 million in the cattle business and employed John Clay to oversee their interests. In the process, a mad scramble ensued to obtain land strategically located to control the essential and limited water supply. Some companies resorted to leasing American Indian reservation lands and to enclosing sections of public domain that alternated with those areas that they had purchased from the western railroads. The aggressive and sometimes illegal activities of the cattle barons made them unpopular with farmers and small ranchers, as well as with the federal government.

In an attempt to bring order to the industry, southern and Great

Plains cattle owners organized regional and territorial associations to supervise roundups, organize detective bureaus to prevent cattle rustling, institute inspection systems to oversee joint shipments of cattle from range to market, and lobby for political concessions. The collective efforts of these associations led to the creation of the Bureau of Animal Industry by the federal government. The boom could not last. Northern ranges were overcrowded, and steps were taken to shut off the long drives from Texas. Even so, overproduction caused prices on the domestic market to tumble steadily between 1884 and 1887.

To make a bad situation worse, climatic conditions in 1885 and 1886 were disastrous. The summers were hot and dry, reaching 110 degrees. One Fourth of July, there was a hailstorm that killed jackrabbits, yearlings, and antelope, and left cowboys with frozen and scarred faces and hands. In Montana, fifty thousand acres of good grassland burned. In the winter of 1886, three-fourths of some herds were destroyed. In November, a blizzard left snow up to the eaves of cabins. In January, a chinook caused the snow to melt, then on January 28, 1887, the temperatures dropped to 15 degrees below zero, with winds of sixty miles per hour. More snow fell, isolating men and animals for six weeks. Small animals smothered in the drifts; Texas cattle froze, unaccustomed to severe winters; heartier cattle could not break the ice to get grass. Some animals resorted to eating tar paper off shacks and the wool off the bodies of dead sheep. Charles Russell, the famous western artist, did his first watercolor, *Waiting for a Chinook*, depicting a humped-up cow circled by wolves, during this winter storm.

SIGNIFICANCE

The basic economic law of supply and demand on the open range and the whims of the weather dramatized the Chisholm Trail's end. Cattlemen reduced the size of their herds, fenced their ranches, made plans for feeding their animals during the winter months, and concentrated on improved breeding. Even with the number of cattle reduced, the market price did not rise during the 1890's. The industry struggled for survival in the decade of transition. The true story of cowboys and ranches has, over time, evolved into Hollywood fiction for the general populace.

W. Turrentine Jackson, updated by Norma Crews

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■ DECEMBER 4, 1867

NATIONAL GRANGE FORMS TO ASSIST FARMERS

The National Grange was the first major organization in the United States to address the social, economic, and educational needs of rural farming populations. Local chapters often became involved in business ventures and political affairs as well, helping to drive down farming costs. The organization also was instrumental in the passage of the Interstate Commerce Act of 1887.

ALSO KNOWN AS: Order of Patrons of Husbandry; the Grange; National Grange of the Patrons of Husbandry

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Agricultural education; Cattle keeping; Marketing and trade

KEY FIGURES

Oliver Hudson Kelley (1826-1913), main organizer of the National Grange movement

William M. Ireland (fl. late nineteenth century), founder and the first treasurer of the National Grange

Caroline A. Hall (1838-1918), Kelley's niece and secretary

William Saunders (1822-1900), first master of the National Grange

SUMMARY OF EVENT

A federal bureaucrat and former farmer, Oliver Hudson Kelley founded the National Grange of the Patrons of Husbandry during the late 1860's out of a deep concern for the plight of persons living in rural areas of the United States. He believed that a fraternal organization for farmers and other country folk would contribute to their social and economic well-being. A tour of the southern states in 1866 confirmed what Kelley had already grasped through his ownership of a farm in Minnesota: Rural life was hardly a paradise.

The Jeffersonian vision of the small farm and contented citizen-farmers had crumbled along the more sparsely settled frontier and backwoods areas. Many rural men and women experienced intense

isolation, and although they might travel long distances to overcome it, social life and community were difficult to sustain. As a member of the Benton County Agricultural Society, Kelley also had come to understand the harsh economic realities of agriculture and had begun plans to improve the farmers' lot. Whether Kelley expected it or not, the Grange would provide the basis for a widespread Agrarian movement for political and economic reform that would rock the major political parties for decades.

In 1867, Kelley left Minnesota to accept a position as a clerk in the U.S. Post Office in Washington, D.C. There, he and William M. Ireland, another clerk who, like Kelley, was a Freemason, began to plan the organization and ritual for a secret society of farmers that would both bind farmers together and advance agriculture. At the suggestion of his niece, Caroline A. Hall, and others, Kelley decided to admit both men and women into the organization. With several other interested government employees, Kelley quickly worked out a constitution. On December 4, 1867, five of the seven men later designated as founders constituted themselves as the National Grange of the Patrons of Husbandry and proceeded to elect officers. William Saunders, a horticulturist in the agriculture bureau, became the first master, but Kelley continued to play the leading role in the organization.

In 1868, Kelley resigned his government position and began promoting the formation of local Granges. He and his team first organized a local chapter, the Potomac Grange, and used it to experiment with the rituals and other organizational aspects. Letters and circulars to farmers around the country, however, elicited only a meager response. Kelley then toured the Midwest, attempting to sell charters at fifteen dollars each for the establishment of local Granges. He met with almost complete failure and was able to continue only by borrowing money and drawing on his wife's small inheritance. Before 1870, only a handful of local Granges had sprung up, mostly in Minnesota and Iowa, and in the next year, only scattered chapters existed in nine states.

Kelley's persistence paid off starting in 1872. The growth rate of the Grange increased sharply. Although only 132 new Granges appeared in 1871, about thirteen thousand formed within the next three years. Most of the Granges were located in the Midwest, but the network extended into almost every state. Deteriorating economic



Poster from the 1876 national centennial year celebrating the core institutions and professions of the United States, giving the farmer pride of place at the center. (Library of Congress)

conditions undoubtedly drove many farmers to seek out organizational remedies. A few months before the Panic of 1873, a farm depression had foreshadowed the national business slowdown. Farmers who may have been looking at the Granges as a social opportunity now spotted the potential for economic mobilization.

Although the early motivations for the Granges may have been social and educational, local chapters often became involved in business ventures and political affairs. The local and state Granges experienced some success in eliminating or reducing the fees of the middleman in purchasing farm equipment and supplies. In some cases, state organizations appointed agents to deal directly with manufacturers. Montgomery Ward and Company, a Chicago-based retailer, incorporated with the express purpose of trading with the Grangers. Spurred by their success in cooperative buying, many state and local Granges expanded into retailing, manufacturing, and insurance.

When the national-level Grange had amassed a surplus from charter fees, it lent \$50,000 to state Granges to assist in their expansions. Most of these enterprises eventually failed, however, because farmers lacked experience in selling and manufacturing; some Granges suffered mismanagement, lost membership confidence, and went into bankruptcy. Moreover, manufacturers, wholesalers, and retailers resisted the Granger initiatives. On the whole, however, the movement was successful in forcing down prices, despite limited success in business ventures.

During the 1870's, several farm-state legislatures passed so-called Granger Laws, which placed maximum limits on railroad and warehouse rates. In *Munn v. Illinois* (1877) and similar cases, the U.S. Supreme Court ruled that state rate-fixing was constitutional. The Supreme Court later reversed itself in *Wabash, St. Louis and Pacific Railway Company v. Illinois* (1886), but the pressure from the Granges helped push Congress to create the Interstate Commerce Commission in 1887, which helped pass the Interstate Commerce Act (1887).

Pressing state legislatures to enact maximum rate legislation enhanced the prestige of the Grange movement nationally. Although the constitution of the Grange forbade political activity, state and local Granges often were active politically. Other farm-oriented organizations were operating at the same time, sometimes more effectively than the Grange in the political arena, but they lacked the national organization and ready identification of the Grangers. To the American public, the farmer-sponsored legislation concerning railroad rates were Granger Laws.

SIGNIFICANCE

Despite these perceived political successes, membership in the Grange decreased between 1875 and 1880 almost as rapidly as it had grown from 1872 to 1875. By 1877, membership was down to 411,000 (half the 1875 total), and by 1880, rosters reflected only 124,000 dues-paying members. Ironically, many of the once-attractive features of the Grange became liabilities in the second half of the decade. Rural Americans had found the cooperative features attractive, but when these business endeavors failed, the overall organization lost credibility. Similarly, when political action associated with the Grange movement was successful, the membership grew, but when

Granger legislation proved ineffective, many farmers withdrew their support.

After 1880, the Grange continued to function as a social and educational outlet for rural populations, a civic center in small towns, and a bastion of the rural lifestyle in the face of urbanization and modernization. Granger-associated insurance companies remained strong into the next century. Granges also worked closely with the expanded state and federal agricultural extension services.

In politics, other farmers' organizations superseded the Granger movement. The Northern, Southern, and Colored Farmers' Alliances of the 1880's became powerful political forces, as did the Populist Party, which hit its peak during the early 1890's. In many ways, these later farmers' organizations were descendants of the National Grange of the Patrons of Husbandry, the first large-scale attempt at agricultural organization in the United States.

Mark A. Plummer, updated by Thomas L. Altherr

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SEE ALSO: May 20, 1862: Homestead Act Opens Western Lands to Farmers; July 2, 1862: Morrill Land Grant Act Promotes Agricultural Education; 1879: Powell Recommends Water Management Schemes for Western Agriculture; June 17, 1902: Reclamation Act Promotes Western Agriculture.

■ c. 1871-1883

AMERICAN BUFFALO SLAUGHTER DRIVES INDIANS TO FARMING

Within a space of a little more than a decade, the numbers of buffalo roaming the plains of North America were reduced from what may have been as many as thirty million animals to only a few thousand. In addition to driving the buffalo to near extinction, mass killings of the animals destroyed the traditional way of life of the Plains Indians and drove many of them to settled agricultural lifestyles.

ALSO KNOWN AS: Bison slaughter

LOCALE: American Great Plains

AGRICULTURAL ISSUES: Ecology and environment; Hunting and gathering; Native American agriculture

KEY FIGURES

William Cody (Buffalo Bill; 1846-1917), frontier scout and buffalo hunter

Philip H. Sheridan (1831-1888), U.S. Army general

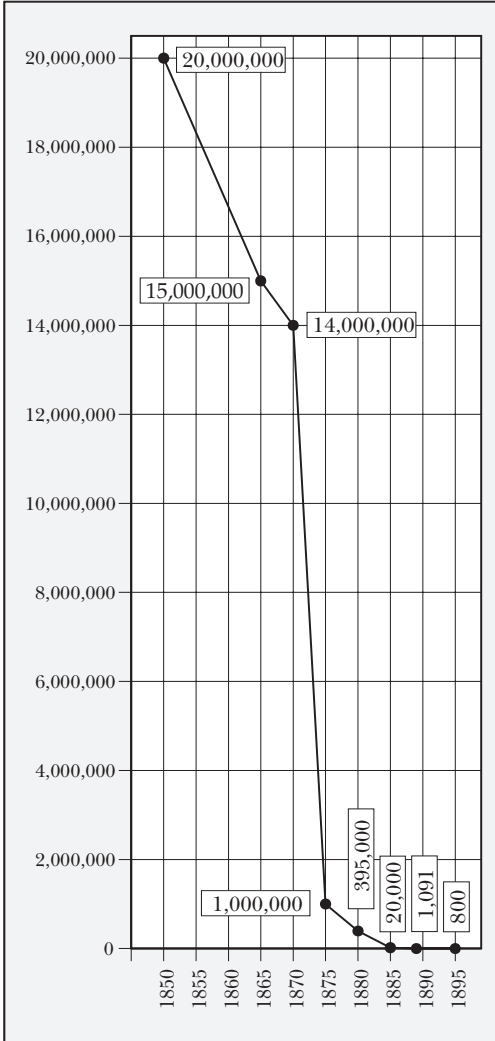
William Tecumseh Sherman (1820-1891), U.S. Army leader in the West

SUMMARY OF EVENT

In 1853, an estimated sixty to seventy million buffalo still roamed the plains of North America. Within thirty years, that number was reduced to a few thousand animals. The precipitous decline of the buffalo was the result of human greed, uncontrolled exploitation, and a U.S. government policy.

Known to scientists as the American bison, buffalo are the largest land animals native to North America. Before Europeans settled in North America, buffalo ranged from the Rocky Mountains to the Atlantic shoreline and from northern Mexico to southern Canada. The greatest concentration of the animals was on the grasslands of the Great Plains. Buffalo provided the basis for a complete way of life for Native Americans living on the plains. They provided food, clothing, tools, and shelter. An important part of the culture of the no-

BUFFALO DEPLETION, 1850-1895



Note: In the twentieth century the buffalo population began to rebound from its 1895 low of about 800; in 2009 it was estimated at more than 350,000.

Source: Data are from Thornton, Russell, *American Indian Holocaust and Survival: A Population History Since 1492* (Norman: University of Oklahoma Press, 1987); Thornton, Russell, *We Shall Live Again: The 1870 and 1890 Ghost Dance Movements as Demographic Revitalization* (New York: Cambridge University Press, 1986).

madic Plains Indians was the buffalo-hide tepee, which could be collapsed quickly and easily transported when communities were ready to relocate. Indians also used hides for blankets, clothing, and shoes. They used the animals' horns to make utensils, cups, powder horns, toys, and decorative items. They used buffalo hair to make rope, halters, pads, and other items. They also used other parts of the buffalo to make soaps, oils, cosmetics, glues, bow strings, pouches, and much more. On the largely treeless plains, the dried droppings of buffalo provided fuel for cooking and heating. Throughout history, few human societies have developed cultures that depended on a single species of animal as strongly as the cultures of the Plains Indians depended on buffalo.

On the northern Great Plains, where the terrain was rugged, buffalo herds feeding near cliffs were often driven over precipices by Indian men and boys waving buffalo robes and shouting, an event known

as a buffalo jump. Other people then rushed in to butcher as many of the animals as they could. Indians rarely intentionally killed more animals than they needed, but buffalo jumps frequently left more animals dead or dying than their pursuers could handle. Contemporary observers described slaughters of from two hundred to two thousand buffalo in such hunts. However, because of the relatively small numbers of Native Americans in North America and the primitiveness of their weapons, the impact of Indians on buffalo populations was slight.

After the U.S. Civil War ended in 1865, U.S. Army troops were freed to go west to battle the Cheyennes, Lakota Sioux, Crows, and other tribes on the frontier. Army units contracted with local settlers to supply their troops with buffalo meat for provisions. Workers constructing the new transcontinental railroad also had to be fed. Contractors included William Cody, who would become better known as Buffalo Bill, who was probably the best known of all the buffalo killers. Hunters frequently skinned the buffalo, cut out their tongues, and took only small portions of the animals' meat, leaving the remainder to rot on the prairie.

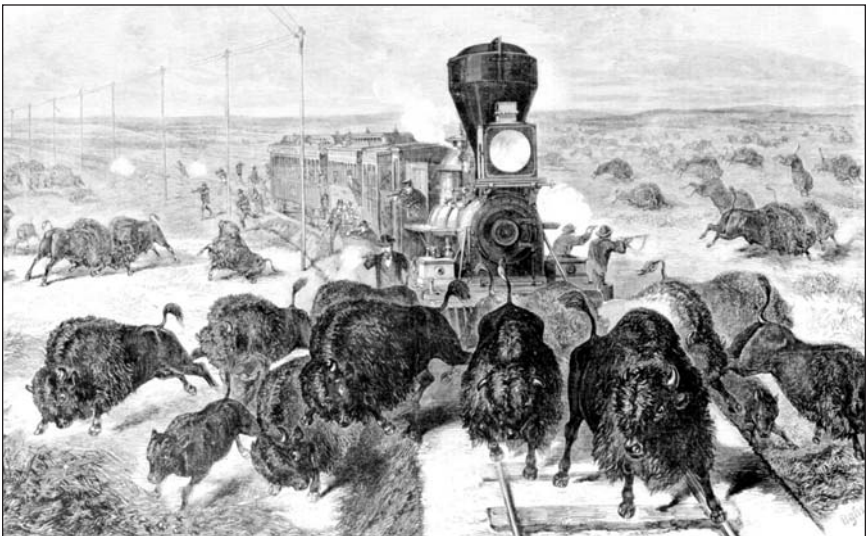
Dressed hides from animals shot by professional hunters were shipped east to be sold as lap robes for winter sleigh and buggy rides or were turned into overcoats. Highly romanticized stories by eastern writers about the exploits of Buffalo Bill and other buffalo hunters quickly made buffalo robes a status symbol. Demand increased, and ever more buffalo were slaughtered. Often only the animals' skins were taken, while their carcasses were left to scavengers. Every year, hundreds of thousands of buffalo were killed for food and hides.

Many buffalo were also killed for sport, as it became popular for people to travel to the Great Plains simply to shoot buffalo. The railroads that linked the East and West cut across the ancient north-south routes of the buffalo. The seemingly endless herds were an annoyance to train crews and a temptation to the passengers. When trains were delayed, passengers often fired into the massed animals, killing some and wounding many more. The railroads encouraged this, with advertising to induce people to ride their trains.

It is difficult to obtain accurate data on the number of buffalo slaughtered. Accurate records were rarely kept, and killings took

place over a wide area. However, partial statistics can suggest what the overall picture may have been. For example, in western Kansas in 1872, approximately two thousand hide hunters each killed about fifteen buffalo a day. At that rate, hunters were killing thirty thousand buffalo per day in that one small region. As soon as herds in one area were reduced so much that hunting became unprofitable, hunters moved elsewhere, seeking larger herds. An 1869 report noted that during a good year, about 250,000 hides were shipped to the New York market alone. That figure is equivalent to the total number of buffalo estimated to be alive in North America at the turn of the twenty-first century. Total railroad shipments to the East between 1872 and 1874 were estimated at 1,378,359 hides.

A peculiarity in buffalo behavior made them particularly easy targets for hunters. Although buffalo could be easily stampeded, hunters firing from ambush could pick off the animals one by one without upsetting herds because the animals simply stood where they were as fellow buffalo were shot and dropped around them. Hide hunters called such a shooting “a stand.” Some members of herds simply poked their noses at their fallen comrades and then calmly returned to grazing. Good hunters could kill seventy-five to one hundred buf-



Passengers on a Kansas-Pacific Railroad shooting buffalo merely for entertainment during the early 1870's. (Library of Congress)

falo per day. One especially skillful hunter won a bet with other hunters by shooting at a stand from ambush, killing 120 buffalo in only forty minutes.

The slaughter of the buffalo was far from a managed or controlled affair. Hunters indiscriminately shot the adults and subadults. Calves were ignored except, possibly, for camp meat. Unweaned, orphaned calves, not yet able to graze the abundant grasses, were left to starve to death. After one particularly large herd was killed, five hundred to one thousand calves wandered off to starve.

While the introduction of professional hunters alone threatened buffalo with extinction, an even more nefarious threat appeared. The U.S. government took the position that the still-warring Native Americans could be subdued if buffalo were denied to them. The U.S. Army began a program of interdiction of the herds. General Philip H. Sheridan spoke out strongly in favor of continuing the slaughter of the buffalo "to settle the Indian question." Sheridan's Civil War comrade, General William Tecumseh Sherman, echoed these sentiments. He stated that the only way to force Native Americans to reservations and turn them into peaceful farmers was to clear the prairies of buffalo. The government further encouraged the slaughter of buffalo by providing free ammunition to hunters.

As early as 1873, significantly fewer buffalo were observed in western Kansas. Hide hunters moved to the northern Great Plains territories and continued the slaughter. The decline spread throughout the range of the buffalo, and it soon became obvious to most observers that the great herds were gone.

The intensive slaughter for hides was brief, occurring mostly from 1872 to 1874, but the activity extended from 1871 through 1883. Most herds were wiped out within about four years, and the hunters then moved on to other areas. Although a few buffalo survived, their numbers clearly slipped below the level that ecologists regard as a minimum viable population size. For many animals, more than one male and one female are required to begin a breeding population. The great slaughter left the prairies littered with buffalo skeletons. For years, farmers gathered cartloads of bones to sell to fertilizer processors. One bone buyer estimated that from 1884 to 1891, he bought the bones of as many as six million buffalo skeletons.

SIGNIFICANCE

While the killings were winding down, neither settlers nor Native Americans could believe that the buffalo were really gone. Many settlers thought that the herds had migrated to Canada and would soon return. Native Americans, drawing on their mythologies, believed that the animals had returned to a great cavern in the ground to reappear when the right prayers were said and the right supplications were made. However, the great herds were, in fact, gone. The impact of the hide hunters' indiscriminate slaughter and the U.S. government's interdiction policy destroyed not only the buffalo but also the Native American nomadic way of life. Reluctantly, but with resignation, Indians were compelled to become farmers on reservations as the U.S. government had sought. Perhaps the worst blow to the Plains Indians, however, was their loss of the religious and cultural relationship they had had with the buffalo. Their entire civilization and lifeways had been destroyed along with the animals on which they depended.

Only a few scattered buffalo and some in private herds escaped the slaughter. Later, brought together in national parks, preserves, and other protected areas, they survived and multiplied. During the late twentieth and early twenty-first centuries, commercial breeding of buffalo for their hides and meat was greatly increasing their number. By the year 2009, it was estimated that about 350,000 buffalo were alive in North America.

Albert C. Jensen

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c. 1871-1883

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SEE ALSO: 9th-15th centuries: North American Plains Village Culture Flourishes; 1867: Opening of Chisholm Trail Expands Cattle Markets; 1874: Barbed Wire Fencing Transforms American Ranching.

■ 1872

CANADA'S DOMINION LANDS ACT ATTRACTS NEW IMMIGRANT FARMERS

Canada's Dominion Lands Act encouraged immigrant farmers to settle in the recently acquired western part of the country. It was modeled after the U.S. Homestead Act of 1862, but it was less successful than the latter act in attracting immigrant settlers and increasing agricultural production until close to the turn of the twentieth century.

LOCALE: Canada

AGRICULTURAL ISSUES: European colonization; Government policy and regulation; Land and land policy; Migration

KEY FIGURES

Sir John Alexander Macdonald (1815-1891), Canadian prime minister, 1867-1873, 1878-1891

Henry Youle Hind (1823-1908), Canadian explorer

John Macoun (1831-1920), Canadian surveyor

John Palliser (1817-1887), British explorer

SUMMARY OF EVENT

The Dominion Lands Act of 1872 was intended to attract settlers to a large area in western Canada formerly known as Rupert's Land. In 1670, Charles II (r. 1660-1685) of England had granted a charter that gave the Hudson's Bay Company control of the land, rivers, and lakes—and a monopoly on the fur trade—in this area of 1.5 million square miles that included parts of what later became western Ontario, Saskatchewan, Manitoba, Nunavut, and Alberta, constituting more than one-third of modern Canada. This arrangement was in force until the mid-nineteenth century, when Canada became interested in creating farming settlements and new provinces in the area.

Accordingly, Sir John Alexander Macdonald, minister of militia affairs for the Province of Canada, drafted the British North American Act, which was passed by the British parliament in 1867. This act created the Dominion of Canada, which included Ontario, Quebec,

New Brunswick, and Nova Scotia. An election that same year made Macdonald the first prime minister and gave his Conservative Party control of the government. Macdonald created an ambitious agenda for nation-building and economic growth called the National Policy. It included adding Rupert's Land and British Columbia to Canada and building a transcontinental railroad. In 1857, expeditions headed by British captain John Palliser and Canadian Henry Youle Hind surveyed Rupert's Land. Palliser's report was extremely negative regarding the agricultural potential of the area, but Hind's more positive report eventually led to the revocation of the Hudson's Bay Company's charter in 1869, when the territory became part of Canada.

The province of Manitoba was created from a portion of the newly acquired territory in 1870, and the rest was designated the North-West Territories of Canada. In 1871, British Columbia became Canada's sixth province. Land and settlement policy debates focused on the concerns of skeptics, who believed that the semiarid western plains were not suitable for farming. John Macoun, a civil servant, was commissioned to survey western Canada and assess its agricultural potential. His report in 1872 (which some said was based on a period of unusually high precipitation) indicated that all regions of the territory were well suited for farming. This report led to the passage of the Dominion Lands Act of 1872.

The law was designed to help populate Canada's western prairies and dramatically to increase agricultural productivity. It provided that any head of household or male at least eighteen years old who paid a ten-dollar fee could have 160 acres of free land, provided the homesteader resided there for three years, kept at least thirty acres under cultivation, and built a permanent dwelling. The act also established the Dominion Lands Survey, which divided the territory into square townships made up of thirty-six sections of 640 acres each, which were then subdivided into the 160-acre quarter-section farms. Dominion Lands policy also stipulated that the Hudson's Bay Company would retain title to about 10 percent of the land, that a large amount of land would be given to the Canadian Pacific Railway to finance its construction, and that several sections in each township would be reserved for schools and other public buildings.

The provisions of the Dominion Lands Act of 1872 closely paral-



Fur-trading post on Vancouver Island in 1859—seven years before Great Britain joined the island with the Colony of British Columbia in the developing amalgamation of Canada. (Library of Congress)

leled those of the U.S. Homestead Act of 1862, which was also part of a comprehensive strategy for settlement of the western plains and economic development. Both laws gave 160 acres to any head of household who would live on, cultivate, and improve the land (five years, rather than three, was the residency requirement under the U.S. act). However, for many years, the Homestead Act was far more successful in attracting settlers than was the Dominion Lands Act, in spite of the fact that the Canadian act allowed homesteaders to purchase at a low price 160 acres adjoining their free parcel in order to double the size of their farms. In Canada, the settlement rate was disappointing, with homestead applications numbering only about three thousand per year from 1872 to 1896. Approximately the same number of homesteaders gave up and left their land annually during the same period. By contrast, the plains of the United States were filling up with homesteaders at that time, and an estimated 120,000 of them were emigrants from Canada.

There were several reasons for the fact that immigration to western Canada was slower than that to the plains of the United States.

Canada experienced an economic recession that began shortly after the confederation of the country, and there was much more frost-free land available in the United States. The U.S. transcontinental railroad was completed before the Canadian Pacific Railway, whose lack initially restricted the transportation of Canadian farm produce.

In addition, when the Canadian Pacific Railway was completed, Dominion Lands Act policy mandated that the free land had to be more than twenty miles from a railway because of the railroad land grants, which increased farmers' transportation costs. In fact, less than half of the farmland in Canada's plains was available for homesteading or for sale at low prices because of the extensive landholdings of the railroad, the Hudson's Bay Company, and "colonization companies," which were granted land in hopes of speeding up the process of development. The need to create 320-acre farms to make wheat farming profitable and the restricted availability of adjacent land parcels frustrated potential settlers and contributed to the high failure rate of homesteads.

Ironically, one of the main reasons for the Canadian government's very limited success in populating its western plains was the promotional campaign that was designed to encourage settlement. The advertisements in this campaign depicted the area as being so rich in resources, including water, wood, gold, silver, and fertile soil, that an utterly inexperienced farmer could realize a profit starting in the first year that would continue to increase thereafter. The unrealistic, romanticized vision of homesteading life presented in these ads even portrayed the cold climate as beneficial, because the water freezing in the ground would expand and break up the soil without the need for tilling.

Thus, many settlers wooed by these advertisements started their farms completely unprepared to deal with the real challenges and hardships of farming in the Canadian West. Typically, water had to be hauled long distances daily. There was no wood for construction or fuel, so cow or buffalo dung was used for cooking and heating, and homes built from sod were damp, insect- and worm-infested, and poorly insulated from the cold. Protectionist tariffs that eliminated American competition allowed profiteers of every type to overcharge for farming implements, supplies, and transportation. Loan payments were demanded on a schedule designed to flood the market

with grain, so speculators could buy it at low prices and reap most of the profits from its production. It is no wonder, then, that each year a large proportion of Canada's homesteaders gave up and left their land until almost the turn of the twentieth century.

As a result of all of these factors, the increase in wheat prices during the early 1880's created an enormous upsurge in the homesteading population of the United States, but there was very little corresponding growth in Canada. After 1896, new dry-farming techniques and more rapidly maturing varieties of wheat resulted in a dramatic increase in Canadian homesteaders and wheat production.

SIGNIFICANCE

By 1930, when the repeal of the Dominion Lands Act ended Canadian homesteading, the goals of Prime Minister Macdonald's National Policy had been achieved. After 1896, when much of the prime land on the prairies of the United States was exhausted, the Canadian West saw a tremendous increase in immigration that populated all of what had once been Rupert's Land and made Canada a unified nation whose borders stretched from coast to coast. Thriving towns and cities were created, and unprecedented economic growth was experienced, as Canada became one of the leading wheat producers in the world.

In addition, this influx of settlers into Canada during the late nineteenth and early twentieth centuries included many immigrants from the United States, western Europe, and other parts of the world. The result was the cultural transformation of Canada into the nation of significant ethnic, linguistic, and religious diversity that it is during the early twenty-first century.

Jack Carter

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SEE ALSO: May 20, 1862: Homestead Act Opens Western Lands to Farmers; 1896: Immigrant Farmers Begin Settling Western Canada; 1904: Marquis Wheat Improves Canadian Agriculture.

■ 1874

BARBED WIRE FENCING TRANSFORMS AMERICAN RANCHING

Joseph Glidden's invention of a new type of barbed wire for fencing had an immediate impact on the American West. The wire's production and proliferation forever transformed the grazing era, revolutionized the physical demarcation of borders, and developed a new symbolism of containment and even oppression.

LOCALE: De Kalb, Illinois

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Innovations

KEY FIGURES

Joseph Glidden (1813-1906), American inventor

Charles F. Washburn (1798-1893), American steel producer

Isaac L. Ellwood (1833-1910), American inventor and businessman

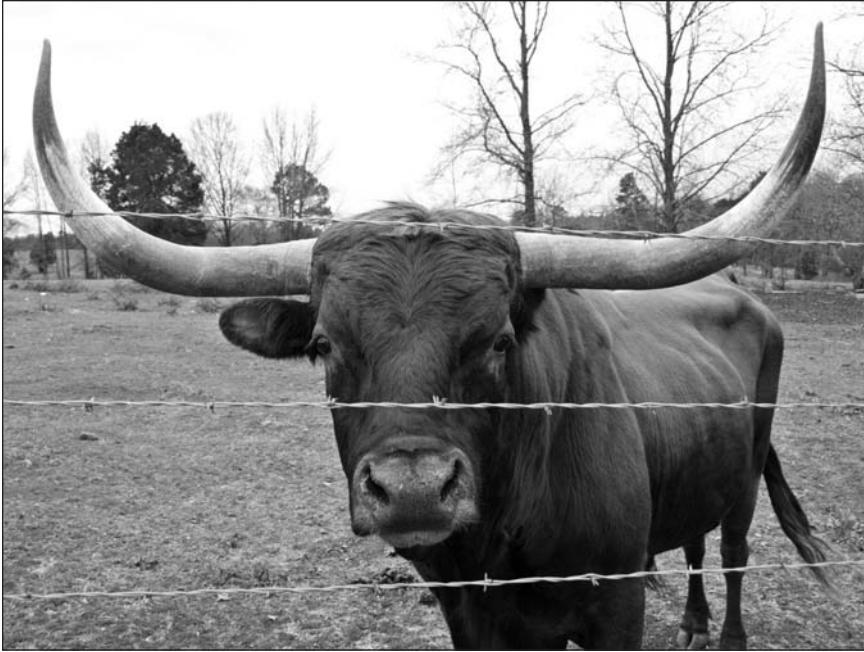
John W. Gates (1855-1911), American financier

Jacob Haish (1826-1926), American inventor

SUMMARY OF EVENT

Upon arriving in the Americas, colonists defined boundaries by heaping stones, brushes, and trees excavated from their fields on an agreed border. Settlers who moved into eastern prairies and the Great Plains found few familiar resources and resorted to earthen barriers, imported Osage orange brush, and other poor substitutes. With the advent of barbed wire and its subsequent mass production, fencing quickly littered the West, acting still as a critical physical barrier in domestic, industrial, correctional, and military facilities.

Late nineteenth century industrialization and the mass production of steel provided the potential for a new durable divider. Between 1860 and 1873 at least nine fence patents were recorded. By 1881 some 1,229 fence designs received recognition from the U.S. Patent Office. The first in the barbed wire family was actually a picket fence with sharp tacks embedded to block livestock. Later, the Hunt



Texas longhorn bull contemplating a barbed wire fence. The barbs on the wire are long enough to deliver a painful lesson to any animal attempting to break through but short enough not to do serious damage. (©David Watts, Jr./Dreamstime.com)

Patent (1867) employed two smooth steel wires with rotating spurs of sheet metal affixed throughout. The Kelly Patent (1868) included the first twisting wires complemented by small spikes and was perhaps the true first modern barbed wire.

Joseph Glidden was born in 1813 in New Hampshire. A year after his birth his family relocated to New York State, where he was raised and received an education. Glidden went on to teach school before moving to Illinois in 1842, claiming six hundred acres of land in De Kalb County. After thirty years of farming and community involvement, Glidden stumbled upon his famous invention—barbed wire. Three varying stories recount the origin of his idea. In one narrative the invention was more an accidental discovery as he worked to untangle two crossed smooth wires; in a second story, Glidden invented barbed wire as a practical means to protect his wife's garden; in yet a third explanation the invention came as inspiration after visiting a county fair in which inventor Henry M. Rose demonstrated a smooth

wire fence on which hung thin sixteen-foot wooden panels embedded with sharp brands. Other soon-to-be rivals likewise attended the same fair and envisioned products similar to Glidden's barbed wire.

Glidden's barbed wire was functional, durable, and eventually became quite cheap to produce. The patent describes the invention as "a twisted fence-wire having the transverse spur wire *D* bent at its middle portion about one of the wire strands of *a* of said fence-wire, and clamped in position and place by the other wire strand *z*, twisted upon its fellow, substantially as specified." More simply put, the invention consisted of barbs evenly placed upon a single smooth steel wire with a second wire wrapped around the first to hold the barbs in place, the wires then attached to posts every fifteen to fifty feet (depending on the topography). Intertwining two wires allowed the fence to expand and contract with the fluctuation of temperature while remaining durable and successfully deterring livestock. Furthermore, Glidden's wire did not aid in the making of snowdrifts, nor did it block vision or oppose otherwise damaging winds—a perfect fit for the plains.

The Glidden patent was challenged several times, most critically by fellow De Kalb resident Jacob Haish. Glidden's first application to the Patent Office dates to October, 1873. On technical grounds of organization, however, the application was rejected, corrected, and re-submitted twice before being granted approval on November 24, 1874 (Patent No. 157, 124). Haish, on the other hand, submitted his application of a similar design after Glidden's original but immediately received the patent in June, 1874, as no other conflicting claim had yet been completed. A legal battle ensued between the two rivals. As late as 1880, Glidden testified against Haish, claiming Haish sent a mechanic to copy his specifications in May of 1874. The legal suit was eventually resolved by no less than the U.S. Supreme Court in an 1892 decision upholding Glidden's patent.

The barbed wire industry pushed forward, even with the litigation. In 1874, Glidden partnered with inventor and businessman Isaac Ellwood, who purchased half the rights to the patent. The two then founded the Barbed Fence Company. They quickly acquired previous necessary patents and, in December, 1874, bought the rights to P. W. Vaughan's barbed wire machine (a step up from Glidden's original converted coffee grindstone). Employing seventy workers in a small two-story building, the company's increasing de-

mand for processed smooth steel wire caught the notice of their supplier, Washburn & Moen Manufacturing Company of Worcester, Massachusetts. After several visits, Washburn & Moen's vice president, Charles F. Washburn, was sufficiently impressed by the design. Finding it easy to mass-produce with advanced machinery, Washburn & Moen partnered with Ellwood in 1872 and bought out Glidden's interests.

Public acceptance of barbed wire was slow initially, but eventually the fence was everywhere in the prairies and plains. Many opposed "the devil's rope" for fear that it would harm the cattle and horses that wandered into the barbs. On the eve of the Texas legislature's motion to outlaw the product, Ellwood dispatched salesmen Henry B. Sanborn and John "Bet-a-Million" Gates to persuade ranchers of its value. In 1875, Gates organized a demonstration of barbed wire in San Antonio's main plaza, wherein he corralled several Longhorns. Impressed by the product's durability and the evident safety of the cattle, as well as the temporary offer to sell the wire at wholesale, Texans quickly converted to the wire. To persuade southern ranchers to adopt it, Glidden and Sanborn organized a ranch fenced with barbed wire in Texas; the ranch led to the development of Amarillo. Soon the product was in widespread use across the plains, by ranchers and farmers seeking to protect their lands.

After Glidden's work ended, Washburn & Moen continued to play a primary role in barbed wire production, buying out and intimidating its competitors. Haish, who lacked comparable production and financial backing, faded into obscurity. In December of 1880, Washburn won a test case before a federal district court that recognized the primacy of its patent and required all competitors to lease rights and recompense back-payment penalties.

In 1887, recently successful competitor (and former employee) Gates pressed Washburn & Moen for a corporate merger. After being rejected, Gates went on to incorporate steel producers, refiners, and barbed wire companies in an enormous monopoly-holding firm named the American Steel and Wire Company of New Jersey. In April of 1899, Washburn & Moen reconsidered and, with the support of other companies, it joined American Steel and Wire. The merger led the newly organized company to control 96 percent of barbed wire production in the United States.

SIGNIFICANCE

The effects of barbed wire have been expansive and far-reaching. Barbed wire fencing rapidly covered the prairie and plains states. In Texas, immense cattle ranches formed to dominate the cattle industry and state politics, in large part facilitated by the new wire. On the northern plains, barbed fences posted by ranchers and farmers created a patchwork that increasingly denied cattle access to grazing fields, water holes, and general passage to railheads, eventually transforming the plains into the agricultural entity of the twentieth century. Quite literally, barbed wire closed the open range, and though barbed wire did not see widespread use outside the United States, ranchers in Argentina and Australia often employed the fence as well.

Military uses for the wire may have begun after its mention in an 1888 British war manual. Teddy Roosevelt's Rough Riders also used the fencing to protect their camps during the Spanish-American War (1898).

Because barbed wire is a common tool for enclosure, it has come to symbolize containment and oppression, evoking uneasy emotions. Perhaps most apparent, barbed wire remains a standard deployment for high-wire entanglements on the battlefield, and it frequently serves to protect and partition military, industrial, correctional, and domestic boundaries. Whether surrounding pastures, prisons, or factories, barbed wire is a surrounding feature of life, even into the twenty-first century.

Matthew R. Garrett

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SEE ALSO: 1867: Opening of Chisholm Trail Expands Cattle Markets; December 4, 1867: National Grange Forms to Assist Farmers; 1879: Powell Recommends Water Management Schemes for Western Agriculture; June 28, 1934: Taylor Grazing Act Extends Federal Control Over Rangelands.

■ 1879

POWELL RECOMMENDS WATER MANAGEMENT SCHEMES FOR WESTERN AGRICULTURE

One of the most influential recommendations for government land management and disposition in the American West came out of an 1879 report made by scientist and explorer John Wesley Powell. He insisted in the report that most of the West was unsuited for settlement and farming as practiced in the humid East, and his work led to the idea of water management, including the use of dams and irrigation projects, as key to Western development.

LOCALE: Western United States

AGRICULTURAL ISSUES: Agrarian reform; Drought; Ecology and environment; Irrigation and water management; Land and land policy

KEY FIGURE

John Wesley Powell (1834-1902), explorer, scientist, and director of the U.S. Geological Survey and the U.S. Bureau of Ethnography

SUMMARY OF EVENT

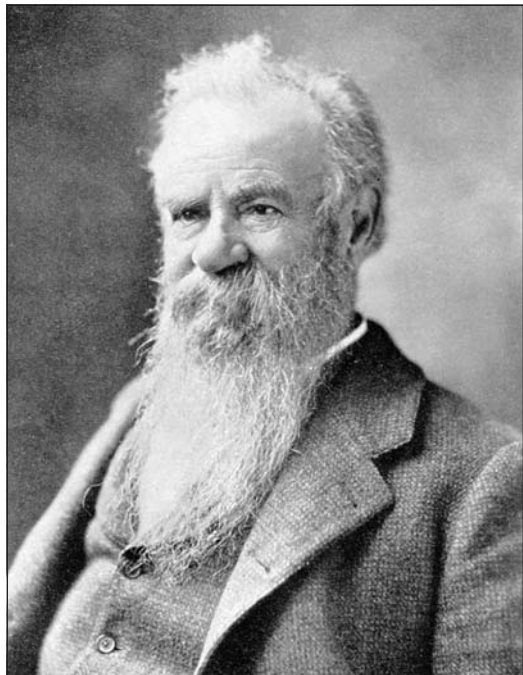
John Wesley Powell achieved national fame through his pioneering voyage down the Colorado River in 1869. Born in 1834 on a frontier farm in New York, he showed an early interest in education and was introduced to science by a farm neighbor in Ohio. He further developed his scientific interests as a student at colleges in Illinois and Ohio. His career as a schoolteacher and lyceum lecturer was interrupted by the U.S. Civil War (1861-1865). A wound that Powell received at Shiloh (Pittsburgh Landing) resulted in the amputation of his right arm, after which his wife and first cousin, Emma Dean Powell, accompanied him in the field. Mustered out of the Army, Powell joined Illinois Wesleyan College as a professor of natural history.

In 1867, after raising money from various state and federal institutions and private business, he set out on an exploratory trip to the

Rocky Mountains. Powell and his wife climbed Pikes Peak and explored the Grand River (now the upper Colorado River) in Colorado. The next year, he returned to climb Longs Peak, explore the White River Valley, and visit Green River, Wyoming.

In early spring, 1869, faced by threats of desertion from his crew, Powell had to curb his wife's managerial efforts. She never again accompanied him in the field. During 1869, Powell began collecting artifacts from the Utes, recording Ute legends, and compiling a Ute dictionary. In 1869, he descended the Colorado River from Green River, going through the Grand Canyon to the mouth of the Virgin River. Only two days before the trip's end, three discouraged men left the canyon, only to be killed by Paiutes.

On July 12, 1870, Congress had established the Geographical and Geological Survey of the Rocky Mountain Region, with Powell in charge. Powell's survey spent ten years mapping the Colorado Plateau in Utah and Arizona, publishing reports on natural history and indigenous tribes. Powell became alarmed by many of his observations and by events elsewhere in the West. Many farmers on the Great



John Wesley Powell.
(Library of Congress)

Plains, deceived by a series of unusually wet years during the 1860's and early 1870's, settled too far West, beyond the hundredth meridian, where normal rainfall, fewer than twenty inches per year, was insufficient to grow crops. When the weather cycle turned dry, many farmers were bankrupted and driven from the land. Much agricultural land also was eroded severely by wind and water. In the Rockies, irrigation companies were gaining control over water supplies, and timber cutters were denuding the mountainsides.

As early as 1873, Powell expressed concern about future settlement in the arid West and recommended changing the land classification system of the United States. In 1879, he published his *Report on the Lands of the Arid Region of the United States, with a More Detailed Account of the Lands of Utah*. (An earlier version of the report was submitted to Congress in 1878 but was corrected and finalized by Powell; it was published as a second edition by the U.S. Government Printing Office in 1879. The second edition is considered definitive.) Because two-fifths of the United States was arid, Powell urged closing public lands to entry until they were topographically mapped and reclassified. Thereafter, the lands were to be distributed to the people according to regulations adapted to Powell's five proposed classes: mineral, coal, pasturage, irrigable, and timber lands.

Powell's report included two proposed laws for organizing irrigation districts and pasturage districts in the western lands. Groups of farmers were to be urged to locate together and form cooperatives, sharing the expense of building dams and ditches to conserve and use water resources. Land units in irrigation districts were to be eighty acres, rather than the accustomed 160. Water rights would inhere in the land, title to the water passing with the land.

Powell recommended abandonment of the rectangular system of survey so that irrigable land could be parceled out, giving each person access to water. He proposed organizing grazing units of twenty-five hundred acres, each unit to include water sufficient to irrigate twenty acres of winter hay or farm crops. Settlers would be allowed to file for holdings without charge, but if the water were not utilized within five years, the land and water rights would revert to the public domain. Powell also insisted that riparian rights under English common law, allowing landowners to take all the water they wished from streams crossing or bordering their property, would have to be modi-



Arizona ranchers collecting alfalfa, an important forage crop for livestock that grows well in arid areas and is ideal for making hay. (Library of Congress)

fied or abrogated in the arid region. Thus, water rights would be limited to the amount required or used on land to be irrigated.

The report also described the lands of Utah and their development as directed by the Church of Jesus Christ of Latter-day Saints (the Mormons) as an example of how his recommendations might be implemented. This part of the report was written by members of Powell's survey: *Irrigable Lands of the Salt Lake Drainage System* by Grove Karl Gilbert, Powell's chief geologic assistant; *Irrigable Lands of the Valley of the Sevier River* by Clarence Edward Dutton, the geologist responsible for geologic reports on the Grand Canyon and the Colorado Plateau; and *Irrigable Lands of That Portion of Utah Drained by the Colorado River and Its Tributaries* by Powell's brother-in-law Almond H. Thompson. Thompson was a mapmaker and the chief topographer for the Powell surveys. Willis Drummond, Jr., contributed *Land Grants in Aid of Internal Improvements*.

Powell's proposals were unpopular with westerners. Many small farmers, too impatient to wait on government land reclassification, thought his program closed the door to opportunity. Others thought

large land units for grazing favored big cattlemen. His reforms also were opposed by railroads, prospectors and mining companies, cattle associations, land companies, and irrigation companies. Thus, Congress failed to act on Powell's recommendations.

SIGNIFICANCE

Although Powell was ignored by Congress, he continued his efforts to reform land policy in the arid lands. He was instrumental in consolidating western geological exploration in the U.S. Geological Survey, which, starting in 1879, continued the topographic mapping he had recommended. He also organized and became director of the Bureau of Ethnology to study American Indian cultures. In 1881, he also became director of the Geological Survey.

In 1887, a decade of drought began, bringing disaster to arid-land farmers and demands for federal irrigation projects. Powell, with the aid of Senator William Stewart of Nevada, secured a congressional resolution in 1888, establishing an Irrigation Survey within the Geological Survey. This resolution also closed entry into most public lands until the irrigable lands had been identified and surveyed. In 1890, however, political opposition drastically reduced funds for the Irrigation Survey. Powell then retired from the Geological Survey and devoted the remainder of his life to the Bureau of Ethnology, which he served as director for twenty-three years.

More of Powell's 1879 proposals were enacted under conservation-minded administrations in the twentieth century. In 1902, the Newlands Act, creating the Bureau of Reclamation, provided for irrigation districts, dams, and canals more or less according to Powell's 1879 recommendations. The Soil Conservation Service, later the Bureau of Land Management, and the Tennessee Valley Authority (TVA), enacted in 1932, incorporate part of Powell's 1879 proposals. Opposition, however, persisted during the 1990's as Republicans called for selling the TVA and western public lands.

W. Turrentine Jackson, updated by Ralph L. Langenheim, Jr.

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■ SEPTEMBER-NOVEMBER, 1880

IRISH TENANT FARMERS STAGE FIRST “BOYCOTT”

The social and economic ostracism of land manager Charles Cunningham Boycott by Irish tenant farmers in County Mayo was a new tactic that addressed the land reform debate in late nineteenth century Ireland. The practice of “boycotting” unpopular land or business owners carried over into the social and labor movements of the twentieth century.

LOCALE: Ballinrobe, County Mayo, Ireland

AGRICULTURAL ISSUES: Agrarian reform; Government policy and regulation; Land and land policy

KEY FIGURES

Charles Cunningham Boycott (1832-1897), Irish estate manager
Michael Davitt (1846-1906), a leader of the Irish Republican Brotherhood and spokesman for the Irish National Land League, 1879-1881

James Daly (1835-1910), publisher and editor of the *Connaught Telegraph* and a leader of the Irish National Land League, 1879-1881

Charles Stewart Parnell (1846-1891), leader of the Irish Parliamentary Party, 1879-1890

John Henry Crichton (1802-1884), third earl of Erne and Irish landowner

William Ewart Gladstone (1809-1898), prime minister of Great Britain, 1868-1874, 1880-1885, 1886, 1892-1894

SUMMARY OF EVENT

During the Irish Land War (1879-1881), a group of tenant farmers engaged in actions designed socially and economically to isolate an estate manager and rent collector named Charles Cunningham Boycott. The action, which lasted from September to November, 1880, was well publicized, and as a result, “boycotting” entered both the lexicon and the arsenal of people attempting to protest actions or to effect change. In that first boycott, the agricultural workers, tenant

farmers, and townspeople of Ballinrobe, County Mayo, were reacting to increases in rents and falling agricultural prices. Accordingly, they refused to work for or sell goods or services to Boycott and his family.

The Boycott episode of 1880 must be placed in the broader context of the organization and mobilization of Irish tenant farmers for land reform legislation and the political struggle for Irish home rule, or self-governance, during the late nineteenth century. Most Irish landlords did not live on their estates and employed land managers to oversee rent collection and run the estates' day-to-day affairs. Since the eighteenth century, nearly all Irish landlords were Protestant, and most tenant farmers were Catholic. In addition to this social and religious divide, there was economic tension as well. As a visible representative of the landlord, the estate manager was a magnet for threats to life and property from disgruntled tenant farmers. The mobilization of the rural populace against Boycott, as well as occasionally violent encounters between tenant farmers and their landlords or estate managers during the Irish Land War, not only characterized the centuries-old struggle for the control of Irish land but also led to parliamentary reforms concerning land ownership, tenant rights, and the setting of fair land prices in Ireland between 1880 and 1903.

Boycott was born near Norfolk, England, in 1832. He purchased a commission in the British army and served out his commission in Ireland. After his discharge, Boycott and his Irish-born wife, Annie, managed a two-thousand-acre estate on Achill Island, County Mayo. In 1873, the Boycotts moved to Lough Mask Estate, near Ballinrobe, to manage some fifteen hundred acres and about forty tenant farmers for John Henry Crichton, the third earl of Erne.

The late 1870's was a period of falling crop prices, and many Irish tenant farmers who had difficulty in paying their yearly rents faced eviction. According to later testimony to a parliamentary commission in 1888, Boycott insisted that tenant farmers make full rent payment or face eviction, regardless of poor harvests. The difficulties over rent prices, payment, evictions, and land ownership came to a head in the summer of 1879. County Mayo farmers banded together in August, 1879, and formed the Mayo Tenants League. The league was led by Irish republican revolutionary Michael Davitt and newspaper owner

James Daly, and it rapidly adopted a policy of socially and economically isolating land managers, their assistants, and persons who purchased an evicted farmer's land.

The protests in County Mayo and the general economic unrest in Ireland were noted by Charles Stewart Parnell, the leader of the Irish Parliamentary, or "Home Rule," Party. Parnell sought a way to gain broader political support, and in October, 1879, he married the issue of Irish independence with land reform legislation in a series of meetings with Davitt. Parnell was appointed president of the Irish National Land League and organized mass political rallies across Ireland through 1880 to promote the twin causes of independence from Great Britain and land reform. The practice of isolating land managers and farmers who purchased evicted rental lands was announced by Parnell September 19, 1880, at a speech in Ennis, County Clare. Five days later, on September 24, the ostracism of the Boycotts began at Lough Mask.

Boycott later testified to a parliamentary commission that all his household servants and agricultural workers had abandoned his service within a week's time after the boycott began. Moreover, local blacksmiths, mail carriers, and grocers refused business dealings with the Boycotts. Boycott reported being "hooted and booed" in the town of Ballinrobe and along the country lanes. Fences and enclosures on the estate were broken down, and livestock was led astray by persons unknown. By the end of September, the Boycotts, their son, and a family friend had to perform every task themselves, including milking the cows, herding the sheep, cooking, and cleaning.

With the harvest only weeks away, Boycott's case was publicized across Ireland and Britain by mainly Protestant, unionist, anti-home rule newspapers. Bernard Becker, a reporter for London's *Daily News*, traveled to Lough Mask in mid-October, 1880, and wrote the first article specifically dealing with the Boycott case. Becker's article was reprinted in major Irish newspapers, and Protestant unionists organized the "Boycott Relief Fund," as well as calling for Protestant volunteers to travel to Lough Mask to help with the harvest.

A group of some fifty Protestant laborers, guarded by more than one thousand British troops, arrived in Ballinrobe on November 11, 1880. The group of laborers and soldiers was greeted by a hail of insults from the locals as they marched to the Lough Mask estate. The



Irish tenant farmers being evicted from their homes on the estate of an absentee British landlord. (Library of Congress)

harvest was completed by November 25. Several threatening letters had been sent to the Boycotts during that time, but the presence of British troops prevented any large-scale disturbance. On November 27, 1880, the Boycotts, the laborers, and the soldiers left Ballinrobe by train to the mixed cheering and jeering of locals.

The Boycotts headed to Dublin, but the threatening letters continued. The manager of the hotel where the Boycotts had lodged was threatened with death if he continued to provide them shelter. Charles Boycott and his family booked the first ferry for England and left Ireland on December 1, 1880. Boycott returned to Lough Mask in 1881 and was again treated to boos and hisses in public. The workers, however, returned to the estate. Boycott continued to manage Lough Mask until 1886 without further incident. He returned to England in 1886 to manage an estate near Suffolk. Boycott died June 19, 1897, on the Suffolk estate.

SIGNIFICANCE

The “boycott” of 1880 demonstrated the growing organizational power of Irish tenant farmers and the Irish Parliamentary Party against Protestant landowners and land managers, as well as in-

creased support for Irish independence. This episode in Irish history also briefly united the militant Irish Republican Brotherhood with the moderate Irish Parliamentary Party. The event and others like it across Ireland also impelled the British government to enact a series of land reforms in Ireland (1880-1903), along with anti-coercion measures that targeted groups such as the National Land League as “revolutionary.”

This carrot-and-stick approach adapted by British prime minister William Ewart Gladstone after the land war of 1879-1881 did little to alleviate the growing political tensions in Ireland. However, the Boycott affair and Irish tenant-farmer agitation did draw Parliament’s attention to tenant rights, the conflict over rent prices, and the right of farmers to sell their lease. The Boycott affair emphasized the close ties between Irish nationalism and the Irish land question during the late nineteenth century.

The social practice of boycotting became a powerful, worldwide instrument for disenfranchised social and ethnic groups through the twentieth century. The practice of passive resistance posited an alternative, peaceful means to gain social, political, and economic objectives, or to at least bring attention to particular grievances.

Tyler T. Crogg

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■ 1894-1895

KELLOGG'S CORN FLAKES LAUNCH DRY CEREAL INDUSTRY

An accidental discovery by the Kellogg brothers led to the making of corn flakes, the first mass-produced, ready-to-eat breakfast cereal. The popularity of Kellogg's Corn Flakes spawned countless imitators as the cereal industry experienced massive growth.

LOCALE: Battle Creek, Michigan

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Food processing; Innovations; Marketing and trade; New crops and food products

KEY FIGURES

John Harvey Kellogg (1852-1943), doctor, medical superintendent of the Battle Creek Sanitarium, inventor

W. K. Kellogg (1860-1951), inventor who founded the Battle Creek Toasted Corn Flake Company

Ella Eaton Kellogg (1853-1920), dietician who managed the Battle Creek Sanitarium kitchen

Ellen G. White (1827-1915), Seventh-day Adventist leader who founded the Health Reform Institute

James Caleb Jackson (1811-1895), doctor who founded the first edible cereal product in 1863

C. W. Post (1854-1914), founder of Post Cereals

SUMMARY OF EVENT

Until the late nineteenth century, most Americans ate the same types of breakfast that their European ancestors had eaten. Diets had been rich in meat, which could be preserved easily in the days before refrigeration. Before being edible, grains had to be cooked and made into bread or gruel. Canned foods were yet to be introduced, and fruit and vegetables were scarce when out of season. Nutritional science was in its infancy, and consumers had no way of knowing if they were getting a healthy diet.

One of the first groups to promote diet as a means of improving health was the Seventh-day Adventists. In addition to their religious beliefs, they also advocated moderate eating habits, temperance, and vegetarianism. In 1866, Seventh-day Adventist leaders Ellen G. White and James White had established the Health Reform Institute in Battle Creek, Michigan. The institute, which featured water treatments known as hydrotherapy, was successful, but it lacked the expertise of a medical doctor. To that end, the Whites partially financed the medical education of one of their parishioners, a teenager named John Harvey Kellogg. Kellogg would complete his medical training and then return to the institute, which he did in 1875. One year later, he became its medical director.

Kellogg immediately began instituting changes in the facility, including changing its name to Battle Creek Medical and Surgical Sanitarium. "The San," as it was soon called, was to become a place where people not only came to get well but also learned to stay well. Kellogg shifted the sanitarium's focus from theology to medical and dietary treatment. His "Battle Creek Idea" revolved around preventive and curative treatments such as a healthy diet, plenty of exercise, and a variety of hydrotherapies. Kellogg encouraged his patients to avoid all meat products and base their diet on vegetables, fruits, nuts, and grains.

Kellogg's mission tapped into what had been a growing health craze in the latter part of the nineteenth century. People believed they could gain control of their bodies through diet, exercise, and other modern curatives. Vegetarianism and temperance were among the popular fads, and the Battle Creek Idea fit right into that scheme. In 1877, one year after Kellogg took over, the San treated three hundred patients. By 1886, less than ten years later, that number had quadrupled, and the San had become the largest institution of its kind in the world.

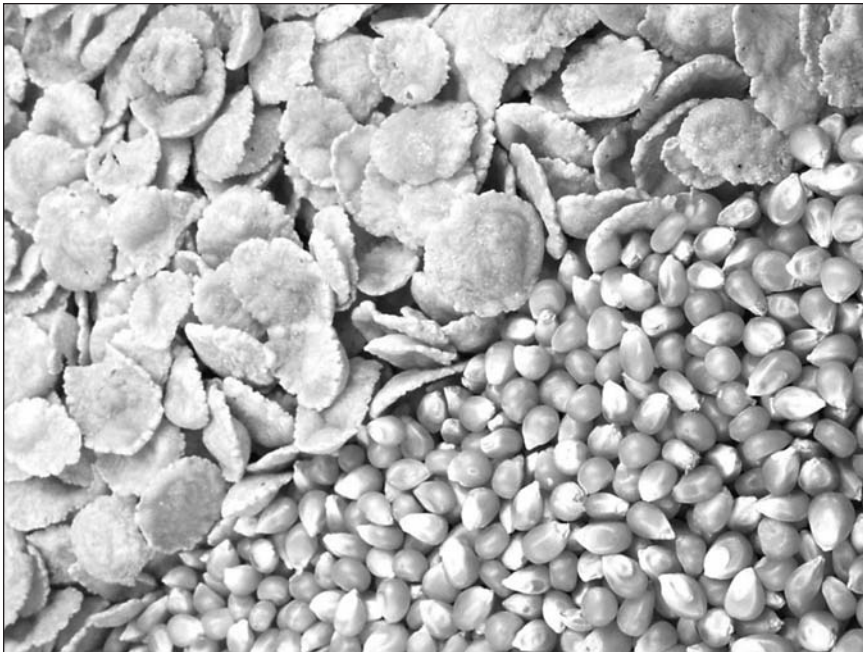
Kellogg hired his business-minded younger brother, W. K. Kellogg, to handle the bookkeeping and marketing, and he placed his wife, Ella Eaton, in charge of the San's kitchen. A trained dietitian, Eaton oversaw the creation of more than eighty new grain- and nut-based dishes designed to replace meat in the diets of wealthy clients.

The breakfast product that would be the precursor to Kellogg's

1894-1895

Corn Flakes was developed in 1894 as an alternative to the hard-to-chew zwieback toast. To create a product that would be easier to chew and digest, the Kelloggs experimented with a variety of grain combinations. The successful corn flakes recipe was developed by accident when a batch of cooked wheat was left to sit out all night. The next morning, the cooked wheat was processed through heavy rollers and emerged in flake form. The end product, then called Granose, was served, with salt, to sanitarium patients. Kellogg applied for his “Flaked Cereals and the Process of Preparing Same” patent on May 31, 1895. The patent application covered the original wheat flakes, as well as barley, oats, corn, and other grains.

Technically, Granose was not the first breakfast cereal, but it was the first to be available in a ready-to-eat form. Another early health pioneer, James Caleb Jackson, invented a cereal product called Granula in 1863, but the bran-based nuggets were so dense that they had to be soaked overnight before they could be eaten.



Corn flakes alongside the corn kernels from which they are made. After kernels are ground into meal, they are mixed with malted barley, cooked, and flattened into flakes.
(©Alena Brozova/Dreamstime.com)

Patients wanted to purchase the Granose cereal and other sanitarium foods, leading the Kellogg brothers to found the Sanitas Nut Food Company to market their food products. Kellogg had little interest in the business end of cereal manufacturing; his priority was the health and well-being of his patients. W. K. Kellogg, frustrated by his brother's lack of interest, decided to form his own cereal company to take advantage of the new fad.

A devastating fire at the sanitarium in 1902 put those plans on hold, and not until 1906 did the new company, the Battle Creek Toasted Corn Flake Company, go into business. This small company, which had started out in a one-story wooden factory, would grow to become the Kellogg Company, the world's largest cereal manufacturer.

By his own choice, Dr. Kellogg did not profit from his discovery, instead supporting his large family (which included forty foster and adopted children) with the proceeds of his writing. He remained the director of the sanitarium until his death in 1943.

The Kellogg brothers were not the only people to succeed during the early days of the cereal industry. Inspired by their success, a former sanitarium patient named C. W. Post began manufacturing cereal and grain-based products in 1895. His first offering was Postum, a grain-based coffee substitute, but he quickly followed with Grape Nuts cereal in 1898 and his own version of the flaked cereal in 1904, first called Elijah's Manna and then renamed Post Toasties in 1904.

SIGNIFICANCE

The early days of the cereal boom have been compared to the California gold rush or a boomtown in an oil-producing region. Would-be cereal barons took advantage of the Battle Creek Medical and Surgical Sanitarium's reputation by prominently advertising that their products, too, were "Made in Battle Creek." With no regulations in place to prevent fraud, some cereal companies extolled the exaggerated health benefits of their products. At its peak, the cereal boom spawned forty-four companies hoping to create the next profitable product in the ready-to-eat breakfast cereal market. Few of the early cereal companies survived the boom, but Kellogg's and Post continued their success; another contemporary, the Battle Creek Cereal Food Company, became part of the Ralston Purina Company in 1927.

The breakfast cereal industry continued to grow throughout the twentieth century, aided by the burgeoning advertising industry. These multibillion dollar industries have changed the way many Americans start their days. In an ironic twist, the same product that started out as “health food” during the late nineteenth century would come under fire during the late twentieth century. Nutritional experts decried the amounts of sugar, processed flour, and artificial colors and flavors in a product that has been marketed primarily to children.

P. S. Ramsey

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■ 1896

IMMIGRANT FARMERS BEGIN SETTLING WESTERN CANADA

To develop Canada's national economy and foster political unification, the government began a campaign to encourage immigrant farmers to settle in western Canada. The campaign led to the first mass migration of Europeans to Canada and the expansion of agriculture and other industries benefiting both the prairie region and the nation as a whole.

LOCALE: Western Canada

AGRICULTURAL ISSUES: Land and land policy; Marketing and trade;
Migration; Population growth

KEY FIGURES

Clifford Sifton (1861-1929), Canadian minister of the interior, 1896-1905

Sir Wilfrid Laurier (1841-1919), Canadian prime minister, 1896-1911

Frank Pedley (1858-after 1913), Canadian superintendent of immigration

William Forsythe McCreary (1856-unknown), Canadian commissioner of immigration

SUMMARY OF EVENT

Toward the end of the nineteenth century, Canada encountered a demographic crisis, as emigration began surpassing immigration. Canadian leaders had sought immigrants to populate the country's vast western territory but were initially unsuccessful. Canada's western prairies challenged farmers, who often abandoned these lands because of their severe climates and harsh living conditions. During the 1880's, approximately one million people moved from Canada to the United States, where they received free land offered by the Homestead Act of 1862.

Sir Wilfrid Laurier, a liberal politician who won the 1896 election for Canadian prime minister, named Clifford Sifton, a farmer's son, minister of the interior with the assignment to direct western settle-



Clifford Sifton sometime after completing his service as Canadian minister of the interior. (Library of Congress)

ment. Sifton, a former Manitoba legislator, capably formulated plans to achieve settlement goals, emphasizing agriculture as essential for Canadian prosperity and focusing on inviting skilled farmers to immigrate. Sifton rejected urban immigrants, however, whom he feared would abandon farmland for cities. Because administrative requirements had impeded some settlers, Sifton closed the Dominion Lands Board, which he blamed for complicating procedures. He clarified the immigration branch's mission to recruit and assist immigrants, and he selected Frank Pedley as his superintendent of immigration in Ottawa and William Forsythe McCreary as commissioner of immigration in Winnipeg.

Sifton believed competent farmers could create an economically appealing situation that would attract businesses and industries to western Canada. He sought to achieve the immigration of many people quickly, and he offered commissions to immigration agents and employees as an incentive for immigration staff to secure as many acceptable immigrants as possible.

During the mid-1890's, Canada had become attractive to immigrants for several reasons. While available farmland in the United States decreased because of settlement and land-law changes, Canada offered ample agricultural resources, especially for growing wheat. International markets demanded Canadian agricultural products because many industrialized nations had limited foodstuff on hand. Crops sold at high prices, assuring farmers some financial security after economic crises had depressed global markets in previous years. People considered immigrating to Canada because European populations significantly increased, overcrowding communities. Canada offered freedom from the oppressive political systems and religious controls of some countries.

Sifton identified incentives to lure agricultural immigrants to Canada. He streamlined the Dominion Lands Act of 1872 to provide adults twenty-one years or older with 160 acres of land if those settlers would reside on that land three years, erect a homestead shelter, grow crops on thirty acres, and give the government ten Canadian dollars to register a claim. To ensure there were enough lands to distribute, Sifton persuaded the Canadian Pacific Railway and other railroads to release lands the government had given them to back railroad bonds and pay for constructing and maintaining lines. Sifton ceased all federal land grants for railroads. He promised immigrants reduced or sponsored transatlantic passage from their homelands and affordable transportation costs, particularly low rail rates to ship goods, within Canada. He encouraged the idea that free land in the United States was scarce and that Canada was the only place to find such opportunities.

Applying business methods to immigration recruitment, Sifton organized an effective campaign. Promotional materials distributed in Europe and Great Britain focused on free farms for immigrants. Sifton established immigration offices in other countries and arranged for translators to prepare brochures that portrayed western Canada as a paradise. Forbidding references to cold temperatures, snow, and isolation, Sifton insisted agents show appealing images, which were contrary to common perceptions of the Canadian prairie.

Sifton hired writers to prepare promotional letters and essays in European newspapers and placed advertisements. He invited to Canada reporters representing United States and European periodicals.

The reporters in turn would view the western Canadian sites and then recommend them to readers. Sifton's representatives touted immigration at public events, especially agricultural fairs and meetings. By 1903, promoters showed audiences a film featuring western Canada. Successful immigrants urged their families and friends to join them.

In addition to recruiting northern Europeans, Sifton considered settlers from the United States, an option previous officials had dismissed. U.S. farmers were familiar with prairie climate and soils, and would have an easier time adjusting to the Canadian climate. Also, Sifton believed that U.S. agriculturists possessed funds, equipment, and skills they could invest in Canadian farming. He directed agents to discuss immigration with white U.S. farmers and to urge the farmers to move their operations and livestock to the Canadian prairie by stressing its similarities with lands they cultivated in the Midwest and western United States. Immigration officials excluded minority farmers, especially African Americans, often rejecting their petitions for homestead lands. Sifton also discouraged immigration by Italians, Jews, and Asians because he believed they would not pursue work in agriculture. Recruitment materials omitted references to people of color and other ethnic minorities.

Sifton believed that central, southern, and eastern Europeans, particularly Ukrainians, Germans, Galicians, Russian Doukhobors, Austro-Hungarians, Poles, and Slavs, would be valuable immigrants. He noted that the attributes of peasants included a strong work ethic and an affinity for agriculture, envisioning that such immigrants could perform seasonal work as needed, migrating across the land to harvest crops. Sifton wanted farmers who would persevere no matter how harsh their environment. Many immigrants were overwhelmed by the large acreage given to them. Some immigrants were uninterested in acquiring homesteads and instead worked for the railroad or other industries.

Sifton circumvented some European laws and policies overseeing emigration. France, for example, discouraged emigration in order to maintain a sufficient military force. Establishing a contract with the North Atlantic Trading Company, an Antwerp group of steamship agents, Sifton secretly offered financial rewards per immigrant to middlemen who persuaded and transported people to Canada.

Sifton paid priests to encourage French Canadians living in the United States to return to Canada. Critics accused Sifton of profiting from his immigration duties, but proof of this was lacking.

Sifton urged immigrants to settle lands adjacent to people from their native country so they could form communities. Such ties strengthened settlements and often led to more immigration. Immigrants would arrive already knowing some settlers. Canadian settlement requirements for immigrants split some ethnic groups. Most Russian Doukhobors, for example, resisted swearing oaths of allegiance, and were thus prevented from participating in any government activities, including education and registering vital records.

Many Canadians resisted Sifton's plans to recruit immigrants but were unable to prevent his efforts. Public reaction targeted some immigrant groups as inferior. Canadians protested that their country risked losing its British culture because immigrants insisted on using their native languages and were uninterested in assimilating. Violent anti-immigration groups often destroyed immigrants' property, and xenophobic attitudes and taxes hindered some immigration. The "alien" labor act (1897) provided measures to restrict foreigners, and by 1898, Sifton was demanding the deportation of Italians who were not settling farmland.

SIGNIFICANCE

Clifford Sifton's immigration policies transformed Canada's western lands into a productive agricultural region. Two million immigrants, mostly skilled farmers, from the United States, European continent, and Great Britain emigrated to Canada between 1896, when Sifton initiated his campaign, and 1911. Immigrants diversified Canada demographically. They applied their expertise to cultivating the Canadian prairies, yielding income from previously fallow land. While Clifton and politicians promoted immigration, scientists and engineers improved agriculture. Farmers benefited from growing wheat and grains suitable for prairie conditions, and they adopted better agricultural tools and methods. Canadian leaders improved transportation systems, mainly railroads, to ease the shipping of goods to numerous markets and make shipping more affordable.

Sifton's settlement plan succeeded so well that available lands soon dwindled. Ambitious agriculturists requested lands the govern-

ment had protected for First Nations peoples, arguing they had more land than their population needed. Sifton agreed. Government leaders seized some indigenous peoples' lands for settlers.

By 1905, the year Sifton resigned his post as minister of the interior, western expansion resulted in officials designating Alberta and Saskatchewan as provinces. Sifton's successor, Frank Oliver, pursued more restrictive immigration policies, seeking only U.S., British, and Canadian settlers for prairie lands. The Immigration Acts of 1906 and 1910 reinforced entry restrictions. Sifton's immigration program had initiated changes that molded western Canada into a thriving agricultural and industrial region for white settlers compatible with eastern provinces and integral in international trade.

Elizabeth D. Schafer

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SEE ALSO: 1872: Canada's Dominion Lands Act Attracts New Immigrant Farmers; 1904: Marquis Wheat Improves Canadian Agriculture.

■ 1901

VITAMIN-DEFICIENT RICE DIET IS LINKED TO BERIBERI

Gerrit Grijns's proposal that beriberi is caused by a nutritional deficiency in a diet of polished rice led to the concept of vitamins.

LOCALE: Javanese Medical School, Batavia, Java

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Disease and health issues; Scientific research

KEY FIGURES

Gerrit Grijns (1865-1944), Dutch physician

Christiaan Eijkman (1858-1930), Dutch physician

Robert Koch (1843-1910), German physician and bacteriologist

SUMMARY OF EVENT

Beriberi is a disease caused by a deficiency of vitamin B₁, thiamine, in the diet. The name of the disease, which is Sinhalese for “I cannot,” came from the fact that people afflicted with severe beriberi are too sick to do undertake the simplest physical tasks. Beriberi was endemic to the Far East in the nineteenth and early twentieth centuries. Its symptoms include stiffness of the lower limbs, paralysis, severe pain, gradual breakdown of the muscles, anemia, mental confusion, enlargement of the heart, and death resulting from heart failure.

By the end of the twentieth century, the incidence of severe beriberi was much lower; the disease was found mostly in undernourished people in the rice-eating nations of Asia, Indonesia, and Africa. In industrialized nations, beriberi is seen most often in chronic alcoholics because their limited diets—which consist mostly of alcohol—are deficient in vitamins in general, including thiamine. Very severe thiamine deficiency in alcoholics results in Wernicke-Korsakoff syndrome, an irreversible disease that causes psychosis and memory loss and requires hospitalization.

Despite the fact that the human body's need for thiamine has been known for many years, a significant proportion of Americans



Distribution of rice during an early twentieth century famine in China, a country in which rice has long been a dietary staple and where records of beriberi go back several thousand years. (Library of Congress)

are believed to ingest barely enough thiamine in their daily diets. By the end of the twentieth century, manufacturers enriched many foods inherently low in thiamine (such as white bread, breakfast cereal, pasta, and white flour) with the vitamin as a health precaution. The best natural sources of thiamine are whole-grain cereals, nuts, and cooked fish (raw fish contains an enzyme that can destroy thiamine). Excessive consumption of tea can lead to thiamine-deficiency symptoms because tea contains a chemical that antagonizes the actions of this vitamin.

Beriberi has been known for thousands of years. For example, reference to a disease with its symptoms is found in the Chinese medical literature of 2700 B.C.E. The Orient is the main beriberi zone because of the population's dietary combination of high tea consumption, use of rice as the main cereal grain, and the common practice of eating raw fish.

In 1887, an important early observation on the dietary origin of beriberi was reported by Takagi Kanehiro, director-general of the Japanese navy. Kanehiro became interested in beriberi because one-third of all Japanese sailors had the disease. After careful study, Kanehiro became convinced that the cause of the beriberi was the standard navy diet—polished rice and fish—which was low in protein. He ordered the addition of red meat, vegetables, and whole-grain wheat to the sailors' diet. After the changes were made, beriberi became rare in the navy.

Around the same time, the work of Christiaan Eijkman and his assistant, Gerrit Grijns, began. The Dutch East Indies (now Indonesia) was becoming a dangerous beriberi zone. The disease was spreading in epidemic proportions in the armed forces, prisons, and general population. Conditions were so bad in Javanese prisons, for example, that a jail sentence was considered to be almost a death sentence. In some afflicted people, cardiac insufficiency and massive edema (swelling) of the legs, symptoms of "wet beriberi," predominated. In patients with "dry beriberi," the main problem was progressive paralysis of the legs. Because of the apparent epidemic nature of the disease, a bacterial origin was suspected. Consequently, the Dutch government appointed a commission composed of two physicians, Cornelius Pekelharing and Clemens Winkler, to study beriberi firsthand. A third commissioner, Eijkman, was appointed after Winkler and Pekelharing asked Robert Koch to join their expedition. Koch demurred but suggested the substitution of Eijkman, a physician who had just completed training in bacteriology with him.

The commissioners arrived in the East Indies in 1886 and immediately began their studies. Within two years, they had shown that beriberi is a result of inflammation of the nerves (polyneuritis). Because they isolated a bacterium from the blood of beriberi victims, the commissioners were satisfied that the disease was of bacterial origin. Winkler and Pekelharing returned to the Netherlands, and Eijkman stayed behind to continue the research and to direct the Javanese Medical School.

Fortuitously, Eijkman observed a disease similar to beriberi in chickens. The diseased animals developed spontaneously all the symptoms of beriberi. Eijkman named the disease polyneuritis gallinarum. In the course of studying the birds, Eijkman had them

moved to new quarters. The disease then disappeared inexplicably. Upon examination, reflection, and study, Eijkman determined that the food given to the birds after they were moved had changed in one important respect: Originally, the birds had been fed on leftover boiled white rice from the officers' ward in the military hospital, but after their relocation they were given unpolished rice because the cook at the new site "refused to give any military rice to civilian fowl."

On the strength of this observation, Eijkman set out to determine whether the polished rice was the cause of the disease. He found this to be the case, because the feedings of unpolished rice cured the dis-

THIAMIN IN THE DIET

Gerrit Grijns proved that thiamin is an essential part of a balanced diet. In the United States, the recommended dietary allowance for children between the ages of nine and thirteen is 0.9 milligram per day. For adolescents between fourteen and eighteen years old, the allowance is higher: 1.2 milligrams per day for males and 1.0 milligram per day for females. Adult males should consume 1.2 milligrams per day, and adult females should consume 1.1 milligrams per day. The list below gives levels of thiamin found in common foods.

<i>Food</i>	<i>Serving</i>	<i>Thiamin (mg)</i>
Lentils (cooked)	½ cup	0.17
Peas (cooked)	½ cup	0.21
Long-grain brown rice (cooked)	1 cup	0.19
Long-grain white rice, enriched (cooked)	1 cup	0.26
Long-grain white rice, unenriched (cooked)	1 cup	0.03
Whole wheat bread	1 slice	0.10
White bread, enriched	1 slice	0.12
Fortified breakfast cereal	1 cup	0.5-2.0
Wheat germ breakfast cereal	1 cup	1.89
Pork, lean (cooked)	3 ounces	0.74
Brazil nuts	1 ounce	0.28
Pecans	1 ounce	0.13
Spinach (cooked)	½ cup	0.09
Orange	1 fruit	0.11
Cantaloupe	½ fruit	0.10
Milk	1 cup	0.10
Egg (cooked)	1 large	0.03

ease. Eijkman postulated that a chemical—perhaps a toxin from intestinal bacteria—was the actual causative agent. Although this concept was not correct, Eijkman's efforts began the scientific research that later showed that thiamine taken from the outer layer (the pericarp) of unpolished rice protected against beriberi.

In 1896, Eijkman left Java and returned to the Netherlands because of ill health. At that time, Grijns took over the study of beriberi. In 1901, he proposed that the disease results from the lack of some natural nutrient substance that is found in unpolished rice and in other foods (that is, a nutritional deficiency). Many scientists now view the work that Eijkman began and Grijns continued as the basis for the modern theory of vitamins.

In 1917, Grijns likewise returned to the Netherlands. By 1921, he had become a professor of animal physiology at the State University in Wageningen. In 1940, he was awarded the Swammerdam Medal for his development of the concept of nutritional deficiency.

Eijkman was appointed professor of public health at the University of Utrecht in 1898. He retained that position for thirty years and completed many other important research efforts during his tenure at the university. In 1929, Eijkman and Frederick Hopkins shared the Nobel Prize in Physiology or Medicine for their roles in the discovery of vitamins. Eijkman was a member of the Royal Netherlands Academy of Sciences and a foreign associate of the American National Academy of Sciences. His other honors included orders of knighthood and the establishment of an Eijkman medal by the Dutch government.

SIGNIFICANCE

Eijkman's observations that beriberi was caused by excessive dietary use of polished rice and that it could be cured by the feeding of unpolished rice were extremely important to the understanding of nutrition. His work set into motion a sequence of events that led to the development of many aspects of modern nutrition theory, the evolution of biochemical explanations for several very serious nutritional diseases, and the virtual eradication of beriberi.

Eijkman believed incorrectly, however, that a curative material in unpolished rice prevented the action of toxins present in the polished grain. In 1901, Grijns was the first to interpret correctly the ac-

tion of this unknown substance. Grijns proposed that beriberi developed because diets that used polished rice only lacked an essential substance that was required for the appropriate function of the nervous system. Grijns and other researchers soon showed that many foods contain the antiberiberi factor and proved that these foods could be used to treat beriberi.

Further studies were conducted in an effort to identify the chemical nature of the substance involved. In 1912, Casimir Funk proposed that beriberi and other nutritional diseases, such as scurvy and rickets, are deficiency diseases caused by the lack of certain substances, each of which is a "vitamine." Funk coined the term because, he said, it "would sound well and serve as a catch word." Others, including Elmer McCollum and Hopkins, had similar beliefs. Soon the term was both accepted and shortened to its current spelling, "vitamin." Subsequently, researchers isolated several types of vitamins and named them A, B, C, D, and so on, in order of their discovery. A key event was the preparation of a pure antiberiberi factor, thiamine (or vitamin B₁), and determination of its structure by Robert R. Williams starting in 1935. This effort led to the commercial synthesis of the vitamin by pharmaceutical companies and to its current wide dissemination.

The availability of the pure vitamin allowed examination of its metabolic rate and actions. It soon became clear that thiamine is an essential component (coenzyme) required for the biological action of a great many important enzymes (biological catalysts). The lack of function of these catalysts was shown eventually to be the cause of beriberi. Very similar results with other vitamins led to the concept that vitamins are coenzymes or parts of coenzymes and that the deficiency diseases produced by their absence are diseases resulting from enzyme inactivation. Thus Eijkman's and Grijns's endeavors to understand beriberi led eventually to the establishment of many basic precepts of nutrition and to the current understanding of the roles of vitamins.

Sanford S. Singer

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SEE ALSO: 1753: Lind Discovers That Citrus Fruits Cure Scurvy.

■ JUNE 17, 1902

RECLAMATION ACT PROMOTES WESTERN AGRICULTURE

The 1902 Reclamation Act provided for federal development of irrigated agriculture and eventually transformed the American West.

ALSO KNOWN AS: Newlands Act

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Ecology and environment; Government policy and regulation; Irrigation and water management; Land and land policy

KEY FIGURES

John Wesley Powell (1834-1902), geologist and director of the U.S. Geological Survey and Bureau of Ethnology

Francis Griffith Newlands (1848-1917), U.S. congressman from Nevada, 1893-1903

Frederick Haynes Newell (1862-1932), civil engineer and chief hydrographer of the U.S. Geological Survey

Theodore Roosevelt (1858-1919), president of the United States, 1901-1909

SUMMARY OF EVENT

Before 1902, irrigation and reclamation policies in the arid western United States were mostly aimed at promoting private and state initiatives to develop irrigated agriculture. On June 17, 1902, the Reclamation Act (sometimes called the Newlands Act) became law after more than twenty years of discussion and failed federal land policy. The act represented the first of several conservation initiatives undertaken by Theodore Roosevelt's administration and set a precedent for active federal investment and direction of natural resources management.

In 1878, John Wesley Powell's "Report on the Lands of the Arid Region of the United States" laid the groundwork for land classification according to the land's capability to produce different kinds of

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goods and services. Early federal land policy initiatives such as the Homestead Act of 1862 and the Desert Land Act of 1877 failed to grasp both the scope of the problem of aridity and the cooperative approaches that would be required to overcome the problem. Powell proposed that federal lands be classified according to their best use and disposed of based on that classification. He suggested organizing lands and local governments on a watershed basis, providing homesteads of 2,560 acres that included a mix of irrigable land and rangeland, and creating cooperative irrigation districts.

Powell's ideas proved unpopular with Congress because they were at odds with the traditional image of the hardy, independent settler. However, the Reclamation Act of 1902, which was passed a few months before Powell's death, incorporated many of his ideas. Public-land scholars have come to recognize his report as one of the most significant documents in American conservation history.

In 1888, Congress authorized the first water-resources inventory of the arid West. Frederick Haynes Newell, an assistant hydraulic engineer with the U.S. Geological Survey (and later that agency's chief hydrographer), took charge of the project and set out to measure water supplies, survey potential dam and canal sites, and calculate the area of potentially irrigable land. Congress had authorized Powell, the director of the U.S. Geological Survey, to reserve all such sites from entry under the public-land laws. Powell's reservation of 127 reservoir sites and thirty million acres of potentially irrigable public land angered western congressmen. In 1890, Congress restored the right of entry to all the withdrawn land except that required for dam and reservoir sites.

Private funding of irrigation efforts had largely come to a halt by the mid-1890's. The most profitable sites had already been developed, and many private projects failed in the financial panic of 1893. State efforts to develop irrigation districts in California and Colorado met with little success. In 1894, Congress passed the Carey Act, which granted one million acres to each western state to promote irrigation. The grants resulted in few projects, however, because limited financing was available. A coalition that supported federal financing of reclamation projects eventually emerged among scientists such as Newell and Powell and economic development interests in the West.

Francis Griffith Newlands came to Nevada during the late 1880's

COMMISSIONERS OF RECLAMATION

Although the Reclamation Act's focus has largely shifted from construction of new facilities to maintenance of existing facilities, commissioners of the U.S. Bureau of Reclamation have continued to play important roles in the development of the American West.

<i>Term</i>	<i>Officer</i>
1894-1907	Charles D. Walcott, director of the U.S. Geological Survey
1902-1907	Frederick H. Newell, chief engineer
1907-1914	Frederick H. Newell, director
1914-1923	Arthur Powell Davis, director
1923-1924	David W. Davis, commissioner
1924-1936	Elwood Mead, commissioner
1930-1936	Mae A. Schnurr, acting commissioner
1936-1943	John C. Page, commissioner
1943-1945	Harry W. Bashore, commissioner
1945-1953	Michael W. Straus, commissioner
1953	Goodrich W. Lineweaver, acting commissioner
1953-1959	Wilbur A. Dexheimer, commissioner
1959-1969	Floyd E. Dominy, commissioner
1969-1973	Ellis L. Armstrong, commissioner
1973-1977	Gilbert G. Stamm, commissioner
1977	Donald D. Anderson, acting commissioner
1977-1981	R. Keith Higginson, commissioner
1981	Clifford I. Barrett, acting commissioner
1981-1984	Robert N. Broadbent, commissioner
1984	Robert N. Olsen, acting commissioner
1985	Clifford I. Barrett, acting commissioner
1986-1989	C. Dale Duvall, commissioner
1989	Joe D. Hall, acting commissioner
1989-1993	Dennis B. Underwood, commissioner
1993-1995	Daniel Beard, commissioner
1995	Stephen P. Magnussen, acting commissioner
1995-2001	Eluid L. Martinez, commissioner
2001	J. William McDonald, acting commissioner
2001-2006	John W. Keys III, commissioner
2006-2009	Robert W. Johnson, commissioner
2009-	J. William McDonald, acting commissioner

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The importance of grain crops to midwestern farmers is celebrated in the Mitchell Corn Palace in Mitchell, South Dakota. Originally built in 1905, several years before this picture was taken, the building is annually covered with thousands of bushels of corn cobs and other grain products in colorful designs. The current structure, rebuilt in 1921, looks very much like the original building. It is a popular tourist attraction, and its arena is used for high school and college basketball games and other events. Similar corn and grain “palaces” have also been built in other midwestern cities. (Library of Congress)

to manage the estate of his wealthy father-in-law, Senator William Sharon. Nevada was rapidly losing population as a result of the end of the silver boom. Newlands recognized irrigated agriculture as one method to promote economic stability, and he became a principal in a privately financed project in the Truckee basin. The project failed, and Newlands suffered a financial loss; in the process, however, he had investigated and acquired many of the potential reservoir sites in the state, which he offered to sell to water users' associations. Upon his election to the U.S. House of Representatives, he became one of the principal promoters of federal financing of irrigation and a prominent member of the National Irrigation Congress, an influential interest group that promoted reclamation.

Upon the assassination of William McKinley in 1901, Theodore Roosevelt became president of the United States. Roosevelt had already become familiar with western land and water issues through his

experience as a gentleman rancher in North Dakota. A progressive Republican, Roosevelt also recognized the political advantages that he might reap from running against large corporate interests and supporting public efforts to conserve natural resources. As governor of New York, he had advocated scientific management of natural resources and had already established relationships with Newell and with Gifford Pinchot, a leader of the forest-conservation movement.

At the prompting of Newell and Pinchot, Roosevelt made reclamation and forest conservation a major theme in his first address to Congress. Given new support from the president, Newlands's proposals gained momentum. His bill authorized federal funding of irrigation projects through a reclamation fund composed of proceeds from the sale of public lands in the West. The bill gave the secretary of the interior discretion in selecting and constructing projects and withdrew the reclaimed areas from all but homestead entries. To promote development of family farms, Newlands included a provision that limited each individual to water rights for eighty acres. His intent was to deny speculation in the federal projects and to reinforce the ideal of the yeoman farmer.

Newlands's bill was opposed by western congressional representatives who wanted a larger water-rights acreage limitation and also wanted the lands to be open to other than merely homestead entries. Newlands compromised and raised the limitation to 160 acres, but the bill was defeated in the House. A rival measure with few of Newlands's provisions passed the Senate in early 1902, and Newlands introduced a new version of his bill. Roosevelt convinced the Senate to incorporate much of Newlands's language into an amended Senate version, and the Reclamation Act became law on June 17, 1902.

SIGNIFICANCE

Perhaps no single law has had a greater effect on the western United States than the Reclamation Act of 1902. The projects that eventually evolved under the Bureau of Reclamation transformed the face and economy of half a continent. El Paso, Denver, Tucson, Phoenix, Los Angeles, and Salt Lake City could not have grown into great metropolises without the massive water development projects and associated hydroelectricity made possible by the act. The agricultural and man-

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ufacturing economies of the western states would also be wholly different without the act and the work it engendered. The Bureau of Reclamation has constructed dams, power plants, and canals in seventeen western states. Its most widely known projects include the Hoover Dam (Boulder Dam) on the Colorado River and the Grand Coulee Dam on the Columbia River in Washington State.

This transformation has come at a substantial environmental price, however. The increased salinity of irrigated lands, the degradation of the Colorado River delta, the demise of salmon stocks in the Pacific Northwest, and the loss of biological diversity caused by the conversion of unregulated rivers to reservoirs are some of the broader costs of irrigated agriculture and hydroelectric power production. These costs must be balanced against the benefits that the western states and the nation as a whole have derived from economic development. In 2005, the Bureau of Reclamation delivered water to



The Grand Coulee Dam on the Pacific Northwest's Columbia River was the biggest project ever undertaken by the Bureau of Reclamation. It was designed to generate electricity and deliver water to irrigate more than one million acres of land. Construction began in 1933, but the dam did not begin providing irrigation water until two decades later. (Library of Congress)

ten million acres of land inhabited by 31 million people. One out of five farmers in the West received water from its projects. Its fifty-eight power plants generated more than 40 billion kilowatt-hours of electricity, serving an estimated six million homes.

In addition to such obvious environmental impacts, the Reclamation Act of 1902 had a number of subtler but nevertheless important implications. Political scientists have observed that the concentration of political power among a "water aristocracy" in the western United States was one result of the failure to implement the original policy of providing for a system of family farms. The act also set a precedent for a growing, activist federal presence in the West that directly controls or influences most forest, rangeland, and water resources in the region.

During the late 1940's, federal subsidies to reclamation programs became increasingly contentious. During the early and mid-1950's, the subsidy issue combined with an awakening environmental movement to block the construction of the Echo Park Dam, which had been proposed for Dinosaur National Monument in western Colorado.

Like other conservation programs designed during the Progressive Era, the Reclamation Act of 1902 envisioned an independent, self-financing funding mechanism to pay for efficient projects. The act established a reclamation fund through the sale of western federal lands. Homesteaders would repay the fund for project construction costs (without interest) within ten years of the time that water became available to them, and the repayments would then allow new projects. By 1914, all projects that could be developed within the ten-year framework had been exhausted. In subsequent acts, Congress extended the period for repayment to twenty years in 1914, to forty years in 1926, and to fifty years in 1934.

The last revision allowed for nonreimbursable allocation of project costs to flood control and navigation. This revision was subsequently interpreted to allow use of electricity-generation revenues to pay irrigation costs that were beyond the financial abilities of irrigators. Even with these provisions, however, the development and approval of projects by the secretary of the interior were limited by poor economic returns. When conservation groups, economists, and Southern California water interests combined to block construction

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of the Echo Park Dam and the larger Upper Colorado River Basin Project during the 1950's, their action marked the end of an era and the once-potent dream of "making the desert bloom."

By the 1970's, growing environmental awareness and poor economic feasibility left the Bureau of Reclamation vulnerable to political change. The Teton Dam, one of the bureau's projects, failed on June 5, 1976, claiming eleven lives and causing damages estimated as high as two billion dollars. In November, 1976, President Jimmy Carter was elected on a platform that stressed environmental protection and governmental reform. In April, 1977, the Carter administration successfully proposed eliminating five of the largest reclamation projects and reducing several others. In addition, the administration proposed reduced budgets and several other reforms that substantially decreased the bureau's powers. Despite a political ideology that favored western development, Carter's successor, President Ronald Reagan, implemented budget reforms that further constrained the growth of federal reclamation projects.

During the early 1980's, controversy arose over the original act's limitation on the size of farms that were eligible to receive federally subsidized water. The government failed to enforce the limitation of 160 acres per farm (320 acres per couple) and associated restrictions on leasing and residency. Attempts by the Carter administration to enforce the law led to the act's revision during the Reagan administration. The 160-acre limitation was raised to 960 acres, and growers were required to pay full cost for water used in excess of the 960-acre limit. By 1988, however, the General Accounting Office found that some farms that exceeded the limit had been divided into holdings of less than 960 acres but had continued to operate as single units. For example, the agency identified a 12,000-acre farm that had been divided into fifteen holdings so that it could continue to receive federally subsidized water at a savings of \$500,000 per year.

One environmental problem facing many reclamation projects has been that of increasing salinity. As fresh water used in irrigation evaporates, it may concentrate and deposit salt in the soil; the elevated salinity levels that result can retard or eliminate crop yields. By treaty, the United States must deliver water containing less than nine hundred parts per million of salt to Mexico from the Colorado River. Because salinity levels were exceeding the legal limit, the United

States built an expensive desalination plant near Yuma, Arizona, to improve water quality. Construction on the plant was completed in 1992, but as of 2005 the facility was not being used; it had operated only for a few months of testing immediately after it was built. Abnormally high water levels in the West throughout the 1990's meant that the United States could meet its treaty obligation to Mexico without operating the plant. During the early twenty-first century, restarting use of the plant, given the expense it would represent, was a controversial topic among Arizona taxpayers.

In the San Joaquin Valley of California, a related problem caused environmental concern. Increasing salinity prompted construction of a drainage system that concentrated farmland irrigation runoff water in the Kesterson Reservoir. The reservoir attracts many migratory waterfowl, and, during the early 1980's, biologists observed that many of the birds were being sickened or killed; by the mid-1980's, researchers confirmed that the cause was selenium poisoning. Selenium, an element occurring naturally in the region's soils, was being carried from irrigated soils and concentrated in the reservoir. A joint state-federal effort was undertaken to investigate the drainage-related problems and develop solutions, and during the 1990's researchers from the University of California became involved in this work. In 2003, they reported some success in using artificially constructed wetland ponds to filter selenium from agricultural runoff.

Overall, the Reclamation Act of 1902 proved successful in reaching its original goal of developing agriculture, commerce, and settlement in the American West. The environmental consequences of that development were largely unforeseen at the time of the act's passage, but they became increasingly problematic in the latter part of the twentieth century.

Donald W. Floyd

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■ AUGUST 12, 1902

INTERNATIONAL HARVESTER BEGINS MANUFACTURING FARM MACHINERY

The founding of International Harvester created a manufacturing giant and brought some order to the fiercely competitive farm machinery industry in the United States.

LOCALE: New York, New York

AGRICULTURAL ISSUES: Marketing and trade; Mechanization

KEY FIGURES

Cyrus Hall McCormick (1809-1884), American inventor and manufacturer of mechanical reapers

William Deering (1826-1913), American industrialist and manufacturer of harvesters and grain binders

George W. Perkins (1862-1920), partner at J. P. Morgan & Company who was the architect of International Harvester and a member of its board of directors

Elbert Henry Gary (1846-1927), attorney and chairman of the United States Steel Corporation

SUMMARY OF EVENT

After much deliberation and several failed attempts, International Harvester Company was formed on August 12, 1902. With assets valued in excess of \$110 million and control of nearly 85 percent of harvester and reaper production in the United States, the company was a combination of the McCormick Harvester Company, Deering Harvester Company, Plano Manufacturing Company, Milwaukee Harvester Company, and Warder, Bushnell & Glessner Company. The creation of International Harvester, along with similar mergers that led to the formation of Allis Chalmers in 1901 and Deere and Company in 1911, grew out of the severe economic hardships and uncertainty of the 1890's and the fierce competition that had come to dominate the harvester and farm machinery industries in the United States. Competition had become so harsh and so damaging to its par-

ticipants that the era is often referred to as that of the “harvester wars.” The consolidation of bitter rivals, most notably the union of McCormick and Deering, was an attempt to bring stability and ultimately profitability back to an industry reeling from years of cut-throat competition and costly patent disputes.

The manufacture and distribution of harvesters and reapers was by the late nineteenth century one of the most conspicuous industries in the United States. It was also an industry dominated by a few large firms held within families, notably the McCormicks and the Deerings. The McCormicks had been in the reaper business from its inception. Cyrus Hall McCormick secured his first patent on a mechanical reaper in 1834 and began selling reapers in 1841. By 1847, he was building a factory in Chicago that would help make him one of the nation’s most prosperous business leaders. William Deering was not an inventor, and he entered the harvester trade in 1870, a generation after McCormick, but through aggressive policies and business abilities he posed a formidable challenge to McCormick for leadership in the industry. Despite being challenged by Deering and a handful of other firms, and even after the death of Cyrus Hall



Cyrus McCormick.
(Library of Congress)

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McCormick in 1884, the McCormick Harvester Company remained the dominant force in the harvester industry.

The heated rivalry that existed between McCormick and Deering had over the years taken its toll on the profits of both companies and had created costly inefficiencies in distribution, losses to dealers, and oversaturation of the domestic reaper and harvester markets. Even though the so-called reaper kings recognized that an end to their costly rivalry would in the end be in both of their interests, all earlier attempts at combination had failed. In 1891, in 1897, and again in 1901, some type of an agreement seemed close at hand, but the differences and old rivalries were always too great to overcome. When William Deering retired in 1901, his sons, Charles and James, took over the management of the company. This renewed hopes that some sort of an agreement finally could be reached in the harvester industry.

The merger was accomplished with the intervention of outside business interests and the assistance of some of the nation's most prominent business leaders, who had a vested interest in restoring and promoting economic stability in a leading American industry and also had personal ties with both the McCormick and Deering families. One of these businessmen was John D. Rockefeller, Jr., whose sister Edith had married one of the sons of Cyrus Hall McCormick, Harold, in 1895. Along with Elbert Henry Gary, chairman of the United States Steel Corporation and a former attorney for William Deering, Rockefeller helped foster the merger that ultimately brought an end to the harvester wars.

Established business leaders had reason to fear the instability and destructiveness produced by price wars and cutthroat competition. In early 1902, Gary telephoned the McCormicks to discuss what he and others perceived as a disruptive development in the harvester industry. In an attempt to cut the rising cost of raw materials, the Deerings recently had purchased iron ore deposits and were building their own rolling mill. This development held the potential to prolong and intensify the harvester wars. Even worse for Gary and other industrialists, it could have broadened the type of predatory competition that monopolies and established business leaders were eager to avoid. The last thing Gary and U.S. Steel wanted was large manufacturing firms beginning their own steel operations. It became appar-

ent that a consolidation of the leading harvester companies held distinct economic advantages for firms in that industry as well as for others.

The details of the merger were worked out over the summer of 1902 in various New York hotel rooms and in the Wall Street offices of J. P. Morgan & Company. The chief negotiator for Morgan was George W. Perkins, then the youngest partner at the firm. Perkins is widely credited with accomplishing what for so long had seemed beyond reach, the creation of a harvester trust. The merger that created International Harvester was organized by the Morgan firm and carried out by Perkins. It was even Perkins who suggested the name for the new corporation. The McCormicks and the Deerings both acknowledged the fact that overseas markets were going to be a large and profitable part of future expansion, prompting inclusion of the word "international" in the new company's name.

International Harvester was the sum of the assets of the five smaller harvester companies from which it was created. To avoid costly antitrust litigation, the merger called for the purchase of the physical assets of the companies rather than of stock in them. After the merger, to provide continuity, to protect the new corporation from speculators, and to attempt to keep peace between the McCormicks and the Deerings, control of the new corporation was placed in a voting trust for the first ten years. This voting trust was given absolute control over the operation of the corporation and acted on behalf of all stockholders. The trust was made up of Cyrus Hall McCormick's eldest son, Cyrus; William Deering's eldest son, Charles; and George Perkins.

The operation of International Harvester was at first a literal combination of the properties and departments of the five companies that had merged. The corporation's executive officers were named to provide a balance of power among the old rivals, but given the initial leverage of the McCormick Harvester Company, the balance leaned somewhat in favor of the McCormick family. Cyrus McCormick was named the first president of International Harvester, and Charles Deering was named chairman of the board. Harold McCormick, James Deering, J. J. Glessner, and William H. Jones of the Plano Manufacturing Company all were named vice presidents of the new corporation.



Mobile advertisement for one of International Harvester's rivals during the early 1920's. (Library of Congress)

SIGNIFICANCE

The creation of International Harvester, like similar mergers in steel, electrical manufacturing, and other heavy industries, signaled both an end to the traditional, family-oriented firms that had dominated in the nineteenth century and the emergence of the modern corporations that would come to dominate in the twentieth century. Modern corporations tend to hire professional managers, exploit economies in production, operate across large markets, and rely on public and sophisticated methods of finance. Ultimately, International Harvester accomplished these things and became a modern corporation, but first it had to be forged out of the rivalries of the leading and distrustful harvester companies.

The emergence of International Harvester also signaled the importance and the impact of the interactions among many of the leading industries in the United States. Industrialists attempted to protect their markets and tended to rely on large trusts to provide a more stable economic environment. Clearly, the involvement of Elbert Henry

Gary in the negotiations to create International Harvester demonstrates that U.S. Steel, the nation's largest steel manufacturer, was concerned about protecting its market. The list of prominent American bankers and industrialists involved in the creation of the harvester trust implies that many business leaders had influence and interests across industries.

The substantial role played by J. P. Morgan & Company in the formation of International Harvester emphasizes how the role of financing had changed by the beginning of the twentieth century. Because of the size and complexity of emerging corporations, the days of widespread internal and family-based financing were gone. Corporations and even the federal government had been turning to J. P. Morgan during the 1890's and twentieth century to help settle financial problems. In addition to its role in the International Harvester merger, Morgan's firm had played a role in the formation of General Electric, American Telephone and Telegraph, Federal Steel, and U.S. Steel.

The formation of such large manufacturing enterprises as General Electric in 1891, U.S. Steel in 1901, and International Harvester in 1902 was indicative of the trend among American corporations to develop and exploit economies of production. Larger firms hoped that by increasing their scales of output they could accordingly lower their average costs of production, distribution, and financial management by avoiding duplication of tasks. After the merger, International Harvester pursued a policy of enlarging both its scale of production and its scope of operations.

In the years after the merger, International Harvester expanded its own production facilities, acquired additional machinery shops, and developed new product lines. The development of new product lines was easier after the merger, because intense competition during the harvester wars had led to reductions in budgets for research and development. The company now could afford to devote resources to long-term research. It began experimenting with gasoline-engine tractors in 1905 and within a few years was marketing a successful line of tractors. Eventually, the company's product lines included trucks, automobiles, construction and earth-moving equipment, lawn and garden equipment, compressors, generators, and pumps for mining natural gas.

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Another significant aspect of International Harvester was the company's part in the movement of American manufacturing firms into international markets. In the period from 1903 through 1909, International Harvester opened production facilities in Canada, Sweden, Germany, France, and Russia. True to the name of the new corporation, it began to market its growing line of farm machinery aggressively across Europe, Africa, and South America. In four years, its volume of trade with Russia reached a level equal to the total volume of U.S. farm machinery exports at the time of the merger.

The formation of International Harvester created a manufacturing giant but did not immediately end the years of rivalry within the harvester industry. Although the merger technically created a harvester trust, the corporation retained the old companies as separate divisions of the new corporation. These separations were easy to define, as the new corporation kept the separate brand names as late as 1909. Despite the efforts of George Perkins, it became obvious that old rivalries were not going to disappear simply because of the merger.

Unfortunately for International Harvester, it paid a price for the continuation of these old, and now internal, rivalries. The company's early years did not produce the economic bounty that was expected. Profits were lower than anticipated, and production declined. Perkins, again with the help of Gary, sought in 1906 to negotiate a settlement between the McCormicks and the Deerings. This time the agreement meant a reorganization and restructuring of the company. After these reforms, which further reduced the direct influence of the family managers, the corporation went public in 1908. International Harvester then entered into an era of substantial expansion and prosperity marred only by a protracted antitrust battle with the U.S. Department of Justice.

Timothy E. Sullivan

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■ 1904

MARQUIS WHEAT IMPROVES CANADIAN AGRICULTURE

The development by agricultural scientists of Marquis wheat benefited Canadian farmers and enhanced the nation's economy by providing early-ripening, high-yielding, high-quality grain compatible with the climate in the western provinces. The Marquis strain soon replaced most spring wheat varieties, extended acreage cultivated, increased exports, and created surpluses.

LOCALE: Ottawa, Ontario, and Saskatchewan, Canada

AGRICULTURAL ISSUES: Botany; Genetic engineering; Innovations; New crops and food products; Scientific research

KEY FIGURES

Sir Charles Edward Saunders (1867-1937), Dominion cerealist, Central Experimental Farm, 1903-1922

William Saunders (1836-1914), director of Dominion Experimental Farms, 1886-1911

Arthur Percy Saunders (1869-1953), chemist and agricultural scientist

Angus MacKay (1841-1931), superintendent of Indian Head Experimental Farm, Saskatchewan, 1887-1914

SUMMARY OF EVENT

During the late nineteenth century, pharmacist William Saunders collected plant samples to propagate new varieties and taught his children horticultural techniques on their family's farm in London, Ontario. In 1886, a parliamentary commission appointed Saunders director of the five original Dominion Experimental Farms, which were headquartered in Ottawa. He assisted in the development of agricultural investigations throughout Canada, improving crop types to increase agricultural production, quality, and profits. Saunders's work also provided the foundation for his sons' work in agriculture.

Farmers in western provinces needed wheat that ripened prior to frosts, and so Saunders traveled to evaluate wheat varieties that thrived in cold and high-altitude regions. He tested Ladoga wheat

imported from Russia, which matured quickly but lacked characteristics desired for baking. Saunders noted that Red Fife wheat, a variety derived from Ukrainian sources, possessed acceptable milling and baking qualities but was slower to ripen. While brothers Charles Edward Saunders and Arthur Percy Saunders completed chemistry doctorates at The Johns Hopkins University, they assisted their father during vacations to develop spring-wheat hybrids that exhibited the traits farmers demanded. The Saunders family started crossing samples in July, 1888, and they devoted two decades to improving spring wheat for cultivation in northwestern Canada, where cold temperatures, wind, and drought often damaged existing wheat varieties. They wanted plants that could endure weather extremes and short summers.

The Saunderses tested crosses between Red Fife and several wheat varieties that matured early enough to be planted and harvested prior to deadly frosts but were inferior for processing. Their efforts included selecting and crossing samples of Red Fife and an Indian import, Hard Red Calcutta, and they produced several generations in order to create adequate specimens. By 1892, Percy Saunders had developed seed for a cross between Red Fife and Hard Red Calcutta called Markham at the experimental farm at Agassiz in British Columbia, and this cross provided the genetic foundation for Marquis wheat.

During the early twentieth century, the need for a better wheat strain intensified as railroads extended throughout western Canada and farmers, who were often immigrants recruited to move to Canada, settled those prairie provinces. The railroad reached the Pacific Ocean, which opened up possibilities for exporting grain beyond local markets, and so farmers wanted to be able to harvest larger yields. Wheat seed imported from Europe, the United States, and eastern Canada proved unsuitable because it required a longer time to germinate and mature. Meanwhile, demand for wheat flour increased as populations grew and milling technology improved.

Hired by his father as a cereal expert in 1903, Charles Saunders focused on breeding experiments with Markham wheat at the Central Experimental Station in Ottawa. He examined wheat descended from his brother's crosses: The best wheat for breeding, he found, had specific qualities, including short stalks and light color. He rejected types, jotting comments in notebooks for each generation he

observed. During August, 1903, Charles Saunders picked a Markham sample—which had ripened several days earlier than other wheat and had the desired texture and quality for milling and baking—and he saved its seeds.

In 1904, Saunders planted the Markham seeds, and he continued to test the wheat produced from that sample and succeeding generations in his laboratory during the following years. He chewed kernels to evaluate gluten quality and also milled grain into flour to bake bread. Saunders kept isolating particular specimens: those that ripened early, produced strong elastic dough that absorbed sufficient water, and baked well. By 1906, he had identified two exceptionally promising wheat specimens, which he called Marquis A and B. For a time he kept evaluating samples, but eventually he concentrated all his investigations on Marquis B.

During 1907, Saunders ground his chosen variety and baked it, proving that Marquis produced larger and more loaves than were produced from bread baked from equal amounts of other wheat varieties' flour. Convinced his wheat strain consistently matured early and demonstrated expected quality, Saunders noted that it also out-produced Red Fife crops by as much as 40 percent.

Saunders gave some seeds to Angus MacKay, the director of the experimental farm at Indian Head, and MacKay tested them in his fields in Saskatchewan. Saunders also distributed seeds to experimental farms in the eastern provinces. Eastern researchers reported minimal differences between the Marquis and other varieties, but MacKay stated that Marquis had the highest yields in tests and had ripened first. After more trials, MacKay agreed that Saunders's hybrid-wheat seed was ready for distribution. Saunders named the new variety Marquis and began promoting it to agriculturists.

By 1909, Canadian farmers, particularly in western prairie provinces, had gained access to Marquis wheat seed. Their satisfaction with its yields resulted in the spread of that strain to the east and south, and soon most wheat growers were planting Saunders's hybrid. Marquis wheat soon replaced Red Fife in many fields, especially in Manitoba, Alberta, and Saskatchewan, because it required five to ten fewer days to grow and could be harvested prior to autumn frosts, which threatened varieties that required longer growing periods. Most millers praised Marquis wheat's processing qualities. Agricul-

Marquis Wheat Improves Canadian Agriculture

tural guides included advice for farmers growing it, and bread manufacturers and mills promoted it in booklets.

The Canadian government supported Marquis wheat, and it became Canada's standard wheat strain. In 1912, Parliament passed the Canada Grain Act, which regulated wheat trading, established a board of grain commissioners, and graded standards to assess quality and fair market pricing. Marquis wheat consistently represented the greatest percentage of wheat and received the highest grade. Many American agriculturists chose Marquis over other wheat varieties, and international exports of Marquis boosted Canada's economy.

Marquis wheat represented 80 percent of Canadian wheat produced in 1915 and 90 percent in 1920. During 1917, cultivation of Marquis wheat earned a total of \$340 million in five Canadian provinces and \$170 million in the United States. In 1918, farmers planted twenty million acres of Marquis wheat in North America. For a time, the number of acres planted with Marquis wheat increased every year. After World War II, however, Marquis's vulnerability to stem rust led to its replacement by Marquis derivatives, and each year farmers planted several hundred million acres of Marquis descendants.



Canadian farmers harvesting wheat during the early twentieth century. (Library of Congress)

SIGNIFICANCE

Marquis wheat dominated grain crops cultivated in western Canada during the early twentieth century. It generated billions of dollars during the first half of the twentieth century, because it was specifically bred to be compatible with prairie conditions. Marquis helped Canada become an international agricultural power that produced record-setting yields per acre. Furthermore, Marquis's yields proved essential to agricultural economic growth and vitality in North America, and its cultivation generated more income than all other crops and livestock sold in Canada.

Marquis wheat enabled Canadian wheat farmers to plant two hundred miles farther north, which invigorated western Canada's economy. Farmers won awards at agricultural fairs in Canada and the United States for Marquis wheat, and judges designated Marquis wheat samples as the most outstanding wheat in the world. Marquis wheat became the source of breeding stock for most modern wheat grown for bread both in Canada and around the world, and scientists used Marquis genes to create hardier strains, such as Marquillo, that could withstand diseases.

The use of Marquis wheat had impacts on many communities in Canada and abroad. Increased yields resulted in the building of more storage elevators, mills, train cars, and ships. Marquis wheat's growing abilities lured immigrants to western Canada, more agriculture-related jobs became available in rural areas, and Canadian governments were able to use taxes from the sale of Marquis wheat to fund education. Marquis's high yields helped Canada produce a surplus of wheat, which provided relief to Canada's European allies during food crises in both World War I and World War II.

Elizabeth D. Schafer

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■ 1907

BREAKDOWN OF RUSSIAN AGRICULTURE CAUSES CATASTROPHIC FAMINE

Czarist Russia's failure to modernize its agricultural system and meet the basic survival needs of its population was obvious when the disruption produced by the Russo-Japanese War, coupled with adverse growing conditions, produced a devastating famine that killed approximately one million people.

LOCALE: Russia

AGRICULTURAL ISSUES: Agrarian reform; Disease and health issues; Drought; Famine and hunger

KEY FIGURES

Pyotr Arkadyevich Stolypin (1862-1911), Russian minister of the interior and prime minister, 1906-1911

Sergey Yulyevich Witte (1849-1915), Russian minister of finance, 1892-1903, and the first constitutional prime minister of Russia, 1905-1906

Nicholas II (1868-1918), last czar of Russia, r. 1894-1917

Vladimir Ilich Lenin (Vladimir Ilich Ulyanov; 1870-1924), Bolshevik leader and revolutionary leader of Russia, 1917-1924

SUMMARY OF EVENT

Even under normal conditions, the threat of starvation was ever present in Russia at the beginning of the twentieth century. By 1900, only one in ten peasant households had enough surplus grain to make it through the winter. In those areas outside the Ukrainian breadbasket, hunger was a constant companion during winter months and early spring. Other factors also made life difficult for peasants. Taxes, often paid in grain, were due at fall harvest time, when grain prices were the lowest. (An avalanche of wheat on the world market from the United States and Canada tended to keep prices low.) Yet the world's highest tariff kept grain imports out of Russia. Western nations were using fertilizers and modern agricultural machinery to boost productivity, but Russian agricultural techniques had re-

mained the same for centuries. There was little surplus capital for agriculture and even less incentive. Most peasants owned land in common and were organized into *mirs*, village groups that shared large plots of divided land. Private landownership was not introduced as part of the 1861 emancipation of serfs, and so profit taking among the peasants was not the norm. Furthermore, poor soil and difficult growing conditions in many regions conspired to make poverty and hunger a constant threat. By 1900, 84 percent of the Russian population still depended on farming to make a living.

Since the mid-1880's, an industrializing Russia had exported an increasing proportion of its wheat crop to produce a favorable balance-of-trade deficit that would attract foreign investments. By 1891, Russia had actually achieved a budget surplus, but hard frosts, a bitter winter, and a drought-ridden, stifling summer produced the worst crop failure since 1848. Owing in large part to the lack of a well-developed railroad system and a road system capable of handling traffic during muddy spring thaws, approximately four hundred thousand peasants starved to death in spite of concerted (although belated) government efforts to distribute rye to famine-stricken regions. The region south of Moscow stretching southeast to the Volga River basin was particularly hard-hit. During the famine, Russia continued to export wheat.

The policy of increasing wheat export continued under Sergey Yulyevich Witte, the czar's finance minister from 1892 to 1903. Under Witte's leadership, Russian industry increased its output during the 1890's by an average of more than 7 percent each year. Russia's urbanization and industrial growth were among Europe's highest. In 1897, Witte committed Russia to the gold standard, making its currency stable but limited in supply, which took a particularly hard toll on the lower classes. Still, the pace of agricultural development did not change, and the onset of another famine was inevitable. Climatic conditions, coupled with sociopolitical turmoil, would result in the famine of 1907 and the loss of an estimated one million lives.

The depression of 1900 slowed Russian economic development and caused a great deal of suffering, especially for the lower classes. Recovery was under way when, in December, 1904, Russia became involved in what it thought would be a short war against Japan. Instead,

Russian forces were reduced on both land and sea. A month after the outbreak of war, the shooting of a large crowd of peaceful demonstrators in the capital (an event still remembered as Bloody Sunday) catalyzed an empirewide revolution against the corrupt and incompetent regime of Czar Nicholas II. Strikes in the major cities were coupled with the seizure of land and the burning of about 15 percent of Russia's manor houses. Both Russia's industrial and agricultural output were seriously affected by the continued upheaval. Only after the issuance of the October Manifesto of 1905, which promised a parliament (Duma), and the Fundamental Laws in 1906 (which limited the representative nature of the Duma) was some degree of normality re-established.

Unfortunately, weather conditions similar to those in 1891 prevented a complete return to normality. By the time the second Duma met in February, 1907, Russia was in the midst of another horrible famine. Sixteen million peasants faced the threat of starvation, and another 45 million suffered from hunger bordering on starvation. In desperation, peasants took part in numerous scattered uprisings in the countryside, but the Duma's debates on agrarian policy issues failed to reach agreement on any single policy. On June 3, 1907, during the time of ideal springtime planting conditions, the second Duma was dissolved. Nearly one million Russians had already died of malnutrition or disease, although relief grain shipments from Europe and the United States helped prevent even more deaths.

As the famine of 1907 approached, there was a concerted effort among peasant representatives to the Duma to nationalize the large landed estates of Russian nobles, which were often used for nonagricultural purposes, and to divide them among the land-hungry peasant communes. In fact, peasant demands were militant enough for the Bolshevik leader, Vladimir Ilich Lenin, to revise Marxist doctrine, asserting that peasants as well as the proletariat could act as a revolutionary force. The opposite conclusion was reached by the czar's conservative minister Pyotr Arkadyevich Stolypin, who as minister of the interior instituted a ruthless policy of repression to rid Russia of radicalism. (The hangman's noose was commonly referred to as "Stolypin's necktie.") Yet in his other role as prime minister, Stolypin advocated the transformation of peasant communes into privately

owned farms. He hoped that the desire for individual capitalist profit would turn the inefficient peasant into a kulak, a productive and possibly wealthy farmer. Stolypin believed that Russian agricultural production would dramatically increase after privatization. Perhaps more significant, however, was his conviction that private landownership would turn peasants into a bulwark of conservative support for the institution of czarism.

Stolypin's plan was initiated by emergency decree in November, 1906. The slow changeover to private ownership, a plan that had little support either in czarist inner circles or in the Duma, did little to lessen the impact of the famine of 1907. However, by 1916, 2.5 million households owned their own farms. The years 1909 to 1913 produced bumper crops, thanks to more favorable weather conditions, and the price of wheat rose on the world market. Also, industrial production advanced with impressive rapidity. When famine and anarchy next struck, brought on by World War I and a major civil war, it would be on a scale far more cataclysmic than that of the famine of 1907.

SIGNIFICANCE

The famine of 1907 brought Russia's lingering agricultural problem to the forefront and made it painfully obvious that Russia needed to modernize its agricultural sector to meet its food needs. The country's evident inability to compensate for the frequently poor growing conditions, or to avoid systemic breakdown when faced with major war, should have led the czarist regime to enact major changes to ensure its own political survival. It did lead one official, Pyotr Stolypin, to put forth a comprehensive plan to turn Russian peasants, who were prone to uprisings, into entrepreneurial farmers with a vested interest in the stability of czarist rule. Stolypin's reforms, however, received little support from the czar's inner circle or from reformist elements in the Duma, and he was assassinated in 1911. The only other official with any sort of grasp of the need for economic modernization, Witte, had been sent into forced retirement five years earlier.

When war came to Russia in 1914, the inefficient and largely unreformed czarist regime became subject to food shortages and uprisings that dwarfed the negative effects of the Russo-Japanese War.

Food shortages along with the inability to control peasant uprisings and huge urban strikes caused the czar's fall in March of 1917. Continuation of the war effort by the new provisional government, which sought reform after the war, caused Lenin to put forth the simple slogan of "Peace, Land, and Bread." The continuation of anarchy provided the opportunity for Lenin's Bolsheviks to seize power in October, 1917.

Irwin Halfond

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■ MAY 20, 1913

CALIFORNIA'S ALIEN LAND LAW TARGETS JAPANESE FARMERS

California became the first U.S. state to pass a measure depriving resident Japanese Americans of property rights.

ALSO KNOWN AS: Alien Land Act; Webb-Henley bill

LOCALE: California

AGRICULTURAL ISSUES: Government policy and regulation; Land and land policy; Migration

KEY FIGURES

William Jennings Bryan (1860-1925), U.S. secretary of state, 1913-1915
Chinda Sutemi (1856-1929), Japanese ambassador to the United States, 1911-1914

Hiram Warren Johnson (1866-1945), governor of California, 1911-1917
Woodrow Wilson (1856-1924), president of the United States, 1913-1921

SUMMARY OF EVENT

Immigration from Japan to the United States increased significantly during the final decade of the nineteenth century, with most of the immigrants settling in the Pacific states. In California, the agricultural skills of the Japanese enabled them to transform land that was previously thought to be unusable for farming into fertile soil that supported crops of vegetables and fruits. As the number of Japanese laborers arriving in California increased substantially, however, strong anti-Japanese sentiment developed. The success of the newcomers threatened and antagonized the emerging labor unions. The Asian Exclusion League was formed in 1905, and a campaign to bar Japanese immigration was launched. Negotiations begun in 1906 between the United States and Japan resulted in the so-called Gentlemen's Agreement of 1907, which limited immigration from Japan to nonlaborers and to families who were joining previously settled laborers. In 1907, a federal immigration bill was amended to prevent

Japanese laborers from entering the United States through Hawaii, Mexico, and Canada.

The California state legislature's attempts to pass alien land bills began in 1907. Although President Theodore Roosevelt's personal intervention, in the form of the Gentlemen's Agreement, prevented the enactment of such bills, the legislature appropriated funds to investigate Japanese agricultural involvement. When the California State Labor Commission submitted a report to the legislature that was favorable to the Japanese, the labor commissioner was publicly reprimanded and the report remained unpublished. By 1910, about 70 percent of California's strawberries were produced by Japanese immigrants, and in 1910, twenty-seven anti-Japanese proposals were introduced in the state legislature. Enactment of the proposed anti-Japanese legislation was prevented that year by influence from the White House and, in 1911, by the direct intervention of President William Howard Taft.

On April 4, 1913, in reaction to a proposed California bill that would prohibit Japanese and other foreigners who were ineligible for citizenship from holding or leasing land in California, the Japanese ambassador to the United States, Chinda Sutemi, made an informal protest to the U.S. Department of State, where he spent two hours with Secretary of State William Jennings Bryan. Regarding the incident, *The New York Times* warned that it could "prove to be the beginning of a serious international difficulty."

The proposed California bill was modeled on an 1897 federal law barring ownership of land by aliens ineligible for citizenship. The federal law, however, contained a proviso that it would not be applicable where treaty obligations conferred the right to own and hold land. The California bill included a clause prohibiting the leasing of land to Japanese, but the Japanese contended that this right had been conferred previously by the treaty of 1894 and reenacted in the treaty of 1911, which provided that citizens of the United States and citizens of Japan would have the right to "own or hire houses . . . and lease land for residential or commercial purposes" in the country of the other.

In Washington, D.C., the introduction of the 1913 California alien land bill was viewed seriously. The prevailing opinion was that its effects could be sweeping and that it could lead to talk of war. When

MAY 20, 1913



William Jennings Bryan.
(Library of Congress)

Secretary Bryan and Ambassador Chinda exchanged mutual assurances of continuing friendship between the United States and Japan on April 4, the Department of State expressed confidence that the matter would be resolved amicably. The following day, Bryan met with the members of the California congressional delegation, who emphasized the necessity of the proposed legislation. They noted that in many parts of California more than half the farms were operated by Japanese, and neither U.S. nor Chinese workers could compete with Japanese labor. They asserted that despite the Gentlemen's Agreement of 1907, which included the withholding of passports from "coolie laborers," such laborers were arriving continuously from Japan. The anti-Japanese feeling in California was so strong, they reported, that individuals who leased land to any Japanese person were ostracized by their neighbors. The members of the delegation intimated that violent protests against the increase in Japanese competition were imminent.

The development of the proposed California legislation was

largely the result of the influence of labor unions and farmers from districts in which the Japanese had acquired land. The labor unions reportedly hated the Japanese because their presence reduced the value of adjacent land and because Japanese laborers worked for low wages. It was fear of the labor unions that impelled members of the legislature to vote for the bill; Californians as a whole did not support the legislation.

In Japan, the Tokyo press vehemently opposed the legislation. An editorial in the *Asahi*, a leading independent newspaper, referred to the "hollowness of American advocacy of equality" and stated, "This anti-Japanese agitation will impress us with a keen sense of humiliation, which will require many years to efface." The National Liberal Party urged the governments of Japan and the United States to prevent passage of the bill. The Japanese government filed a formal protest on April 7, but President Woodrow Wilson's position was to remain outside the conflict. He believed that the proposed legislation lay within California's rights as a state. On April 10, it was reported that if California made no attempt to violate treaty obligations, the administration would not oppose the bill. President Wilson had concluded that the precise limitations of federal and state jurisdictions in the matter should be determined by the courts.

The final draft of the new law was adopted by the California Senate on April 12. Ambassador Chinda presented his government's formal protest against the bill to the U.S. Department of State. Secretary of State Bryan delivered a complete copy of the Alien Land Act to the Japanese ambassador on April 14, after it passed its second reading in the California legislature and so became properly eligible for diplomatic consideration. Because of agitation in Tokyo, where the bill was denounced by the press and where demonstrators were calling for war, the California legislature, despite overwhelming margins in favor of passage in both houses, delayed further action until May 20, 1913. On that date, the Alien Land Act, known also as the Webb-Henley bill, was signed into law by Governor Hiram Warren Johnson. The statute barred all aliens who were ineligible for citizenship, as well as all corporations with more than 50 percent ineligible alien ownership, from the legal right to own agricultural land in California. It also limited the duration of land-leasing contracts in the state to three years.

MAY 20, 1913

SIGNIFICANCE

After passage of the California law, antialien agitation began in Michigan following announcements that Japanese laborers from California were going to settle in Michigan's Alger County. During 1917, alien land laws were introduced in the state legislatures of Oregon and Idaho, but, because of the crisis in Europe at the time, they were subsequently withdrawn. An alien land law was enacted in Arizona, however.

California's 1913 statute was not entirely effective. To prevent Japanese residents from circumventing the law, the California legislature introduced a more restrictive alien land bill in 1920 to forbid the Issei (first-generation Japanese—that is, immigrants to the United States from Japan) from buying land in the names of their U.S.-born children, the Nisei. It also prohibited the transfer of land to noncitizens by sale or lease and established criminal penalties for aliens caught attempting to bypass the 1913 law. In a statewide ballot, California voters passed the 1920 Alien Land Act by a three-to-one margin. Japanese residents of California instigated a number of cases to test the constitutionality of the new law, and in 1923, the U.S. Supreme Court ruled against the Issei in four of these cases. Further restrictions also were passed in a 1923 amendment, which, together with the federal 1924 Immigration Act, effectively denied further immigration and determined the status of Japanese immigrants in the United States. California's alien land laws were not repealed until 1956.

In 1921, Washington, Texas, and Louisiana enacted alien land laws based on the California act, as did New Mexico in 1922 and Oregon, Idaho, and Montana in 1923. These laws differed from the California statute only in small details. Other states followed: Kansas in 1925; Missouri in 1939; Utah, Arkansas, and Nebraska in 1943; and Minnesota in 1945. Although alien land laws were eventually declared federally unconstitutional, not all states had officially rescinded these laws by the end of the twentieth century.

Susan E. Hamilton

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■ 1917

AMERICAN FARMERS INCREASE INSECTICIDE USE

Entomologists' development of a technique to poison the cotton boll weevil led to intensified and widespread use of insecticides and diminished support for cultural and biological controls of insect pests.

LOCALE: Tallulah, Louisiana; Lake Village, Arkansas; Scott, Mississippi

AGRICULTURAL ISSUES: Chemistry; Pests and pesticides; Scientific research; Textile industries

KEY FIGURES

Bert Raymond Coad (1890-?), entomologist with the U.S. Department of Agriculture

Charles Valentine Riley (1843-1895), American naturalist and entomologist

Leland Ossian Howard (1857-1950), chief of the Division of Entomology at the U.S. Department of Agriculture

SUMMARY OF EVENT

The use of chemical insecticides in the United States intensified during the 1920's following the development of a technique to poison the cotton boll weevil, one of the nation's worst agricultural pests. Insecticide use had become established in the nineteenth century, when exotic pest insects arrived on steamers with European immigrants and on cargo ships.

As early as 1868, an unknown farmer discovered that Paris green (a brightly colored dye often used to paint window shutters) could kill the Colorado potato beetle. The active toxic ingredient in Paris green was arsenic, a poison also employed in insecticides developed later, such as London purple and lead arsenate. In a letter to the editor of the *Galena Gazette* on May 28, 1869, a Wisconsin farmer informed Illinois potato growers that an early-morning dusting of Paris green mixed with flour would kill beetle larvae. This advice was re-

peated in the July issue of the *American Entomologist*, and the practice of using Paris green on the potato beetle rapidly gained acceptance. During the 1870's, Paris green was found to be effective against other pests as well, and it soon became a standard insecticide for the American farmer.

The nation's agricultural industry had a serious need for insect control. In 1870, for example, journalist Horace Greeley estimated that the average annual loss to farmers from insect damage exceeded \$100 million. Assisted by the Division of Entomology in the U.S. Department of Agriculture (USDA), farmers found themselves with three basic strategies for fighting pest insects: insecticides, biological controls, and cultural controls. By the 1920's, insecticides had emerged as the principal means of insect control, in large part because of the Division of Entomology's experience with three pests: the cottony-cushion scale, the gypsy moth, and the cotton boll weevil.

The cottony-cushion scale had been accidentally imported from Australia or New Zealand during the 1870's. Arsenicals had limited effect on the pest, so there was little to prevent its rapid spread through the orange and lemon groves of California during the 1880's. Charles Valentine Riley, first chief of the USDA's Division of Entomology, noted that the cottony-cushion scale posed a significant problem in New Zealand. He concluded that the species was native to Australia and had been kept in check there by natural enemies, so it was neither abundant nor injurious.

Riley sent his assistant, Albert Koebele, to Australia to search for the scale's natural predators. Koebele returned in 1889 with a small beetle that preyed on the scale. Known as the Australian ladybird, or vedalia beetle, the new predator became so effective that the scale was brought under control in the first season after the beetle's release. The results of this experiment aroused great enthusiasm among farmers and entomologists, many of whom saw biological control as the solution to the war on insects and boldly predicted that spraying insecticides would no longer be necessary. By 1920, however, this confidence in biological control had been replaced largely by a renewed faith in insecticides.

The gypsy moth had been introduced into the United States in 1869 by Leopold Trouvelot, a French-born astronomer with an avocation in the breeding of silkworms. He imported from Europe the

eggs of the gypsy moth—a leaf-eating insect known to be harmful to trees. Some of the insects escaped from Trouvelot's laboratory and gradually became established near his home in Medford, Massachusetts. Twenty years after the accidental release, their population exploded. Writing in 1930, the chief of the Division of Entomology, Leland Ossian Howard, described the infestation of caterpillars that invaded the town in 1889: "The numbers were so great that in the still, summer nights the sound of their feeding could plainly be heard, while the pattering of their excremental pellets on the ground sounded like rain."

The caterpillars created a nightmare for Medford, defoliating trees, covering sidewalks and fences, and invading food and bedding inside houses. They were found to be resistant to Paris green and able to consume nearly ten times the amount of arsenic required to kill caterpillars of other species. Increasing the proportion of arsenic merely burned the foliage. Relief came in 1892 when the chemist F. C. Moulton found that lead arsenate could kill the caterpillar without as much injury to foliage as that produced by Paris green. Lead arsenate proved effective on the moth and on other insects; during the early twentieth century, it became the most popular insecticide until it was replaced by dichloro-diphenyl-trichloroethane (DDT) during the 1940's.

After the California experience with the vedalia beetle, however, many believed that ultimate control of the gypsy moth would come when a suitable insect predator was found. Financed by state and federal funds, Howard traveled to Europe to search for natural enemies of the moth. Progress was slow. In Europe, the gypsy moth was kept in check by fifty parasites, and control in the United States might require importing all of them. Finally, in 1930, Howard concluded that biological control was far more complicated than entomologists had believed twenty years earlier and that the successful experience with the vedalia beetle had been an exceptional case. Although some control was eventually achieved through the introduction of natural enemies, the gypsy moth generally was kept in check through the use of lead arsenate.

The cotton boll weevil problem furnishes an example of why cultural insect controls largely failed in American agriculture. The USDA was alerted to the boll weevil problem in 1894, when it re-



State plant-quarantine inspector checking produce brought into California during the 1930's. To protect its vast agricultural industry, California pioneered in plant-quarantine legislation designed to keep insect pests and plant diseases from entering the state. (Library of Congress)

ceived word from Corpus Christi, Texas, that a peculiar weevil had destroyed much of the “top crop” of cotton (a late harvest possible whenever the first frost arrives late). Local farmers found that ordinary poisons had no effect on the pest. Howard immediately dispatched entomologist C. H. Tyler Townsend to investigate the infestation. Townsend found extensive crop damage and recommended cultural control measures, such as burning or flooding the stalks after the main harvest to eliminate the weevil’s food source prior to hibernation and the establishment of a fifty-mile-wide noncotton zone along the Texas international border to prevent further in-migration of the insect from Mexico.

By the end of the next year, the boll weevil had spread well into Texas. Strong opposition from constituent farmers forced state legislators to decide against a noncotton zone on the Mexican border. Farmers also rejected other cultural control measures recommended by the Division of Entomology for socioeconomic reasons. Destruction of the crop after the main harvest, for example, would deprive farmers of the chance for a top crop and thus posed an immediate economic cost with no guarantee of a more profitable harvest the next year. Furthermore, if neighboring farmers did not employ the same measures, the weevils would continue to thrive in nearby fields.

It was known that weevils fed from the cotton squares and bolls through deep punctures, thus avoiding poisons, which would remain on the surface tissue of the plant. Nevertheless, Texas farmers used an estimated twenty-five boxcarloads of Paris green during a three-month period in 1904 in futile attempts to destroy the boll weevil. A breakthrough finally occurred in 1914 when bureau entomologist Bert Raymond Coad saw the possibility of poisoning the insect by means of the dew on the leaves of cotton plants. Over the next three years, he experimented with this idea on cotton plantations in Louisiana, Arkansas, and Mississippi. The results of these tests were highly encouraging.

Numerous large-scale experiments were conducted in 1917 and 1918, and the success of these tests led to USDA guidelines on poisoning the boll weevil. Coad had found calcium arsenate to be more poisonous to the insect than other arsenicals. His experimental work also verified his theory that the weevil's habit of drinking from water on the plant's surface could be used to introduce the poison. He recommended that farmers dust their crops at night, when the plants were especially moist from the dew. The combination of the new insecticide and the approach of poisoning weevils through their drinking rather than their feeding habits proved effective in controlling cotton damage caused by the pest. An insecticide again had provided the most convenient form of insect pest control.

SIGNIFICANCE

During the 1920's, American farmers became increasingly reliant on the utility offered by insecticides. No other method, it seemed, would stop insects as effectively as chemicals. New techniques were developed to increase the ease and efficiency of insecticide application. In 1922, for example, Coad demonstrated the possibility of dusting cotton crops from the air; by 1927, one aerial crop-dusting company had contracts to treat one-half million acres of cotton.

The manufacture of insecticides developed into a large industry that provided further encouragement and support to farmers inclined to dust and spray. Prior to 1918, for example, only one manufacturer was making calcium arsenate, with a total annual production of about 50,000 pounds. Two years later, twenty-five manufacturers were making it, and their combined output was more than ten mil-

lion pounds per year. The sharp increase in production reflected the new demand for calcium arsenate as an insecticide for the boll weevil. From the time of Coad's discovery in 1917, production continued to grow until calcium arsenate became the second most common arsenical insecticide in use, next to lead arsenate. The annual production of lead arsenate increased from 11.5 million pounds in 1919 to more than 37 million pounds in 1931. Annual production of calcium arsenate by 1931 had climbed to more than 26 million pounds.

In 1924, A. G. Ruggles, president of the American Association of Economic Entomologists, complained that young entomologists were not dedicating enough time to the study of insects; instead, they were experimenting with insecticides to control pests even before they had thorough understanding of the life cycles of those insects. Publicly funded economic entomologists were under pressure to make recommendations on control methods they knew would produce immediate results, and chemical insecticides had become the most efficient weapons in the war on insects.

Some commentators raised public health concerns about chemical residues on food shortly after Paris green first gained popularity as an insecticide, but the U.S. government did not set tolerance levels for arsenic and lead residues until the 1920's and 1930's. These levels, set by the USDA, were based more on what the department believed industry could achieve through washing than on information about safe amounts of exposure. With few exceptions, government officials were looking for evidence of acute poisoning rather than chronic health effects from long-term exposure to spray residues. The potential for cumulative impacts from lifetime ingestion of these chemicals did not become an important issue for public debate until after the publication of Rachel Carson's *Silent Spring* in 1962.

The popularity of arsenical insecticides prepared the way for the rapid, almost indiscriminate, acceptance of DDT when it became available after World War II. By 1945, insecticides were already well established in the social and technological framework of American agriculture. It was not until the 1960's, however, that the general public became aware of indirect health effects resulting from insecticides that washed off the land into streams and lakes, poisoning fish, wildlife, and humans.

Robert Lovely

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■ 1917

BIRDSEYE'S QUICK-FROZEN FOODS TRANSFORM AGRICULTURE

Clarence Birdseye's development of a technique for quick-freezing fresh foods led to the creation of the frozen-foods industry and helped transform agriculture by reducing the urgency of getting produce to markets before it spoiled.

LOCALE: Gloucester, Massachusetts

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Food processing; Innovations; Marketing and trade; New crops and food products

KEY FIGURES

Clarence Birdseye (1886-1956), American scientist and inventor

Donald K. Tressler (1894-1981), American food preservation researcher

Wetmore Hodges (d. 1957), American businessman

SUMMARY OF EVENT

In 1917, Clarence Birdseye developed an inventive process for quick-freezing meat, fish, vegetables, and fruit without substantially changing their original tastes. *Fortune* magazine called his system of freezing "one of the most exciting and revolutionary ideas in the history of food." Birdseye went on to refine and perfect his freezing method and to promote the frozen-foods industry until it became a commercial success nationwide.

Even as a boy, Birdseye was interested in preserving things, animal skins in particular. By the time he was a teenager, he considered himself an authority in taxidermy and placed an advertisement in a sports magazine announcing courses at his newly founded American School of Taxidermy. Later, he worked as a fur trader in Labrador, where his interest in quick-frozen foods first began. During one of his Labrador trips, Birdseye's new wife and five-week-old baby accompanied him. In order to keep his family well fed, he placed barrels of fresh cabbages in salt water and then exposed the vegetables to freez-

ing winds. When this proved successful, he went on to freeze a winter's supply of ducks, caribou, and rabbit meat.

This was the start of the frozen-foods industry. In the following years, Birdseye experimented with many freezing techniques. He started with only seven dollars, with which he purchased an electric fan, cakes of ice, and buckets of salt brine. His earliest experiments were on fish and rabbits, which he froze and packed in old candy boxes. By 1924, he had borrowed against his life insurance to continue his research and was fortunate enough to locate three partners to invest in his new General Seafoods Company (later renamed General Foods), located in Gloucester, Massachusetts.

Although it was Birdseye's genius that put the principles of quick-freezing to work, Birdseye did not invent quick-freezing. The scientific principles involved had been known for some time when he put them to use. During the mid-nineteenth century, ice-salt systems were used to freeze foods. As early as 1842, a patent for freezing fish was granted to H. Benjamin in England, and in 1861 another such patent went to Enoch Piper in Maine. Nevertheless, the commercial exploitation of the freezing process could not have happened until the end of the nineteenth century, when mechanical refrigeration was invented.

Even with the refrigerator, however, Birdseye had to overcome major obstacles. By the 1920's, few mechanical refrigerators were yet found in American homes, and it was years before adequate facilities for food freezing and retail distribution were in place across the United States. By the late 1930's, frozen foods had, indeed, found their role in commerce, but they still were not important competitors with canned or fresh foods.

Birdseye became a prime mover of the industry, working tirelessly, writing and delivering numerous lectures and articles to advance the popularity of frozen foods. His efforts were aided by scientific research being conducted at Cornell University by Donald K. Tressler and at Massachusetts State College (now the University of Massachusetts at Amherst) by C. R. Fellers. Also, war conditions advanced public acceptance of quick-frozen packaged foods as rationing, combined with a shortage of canned foods, contributed to demand. The armed forces made large purchases of these items as well.

Although Birdseye's new company was not the first to freeze whole fish commercially, General Foods was the first to use a system of ex-

Block of frozen spinach awaiting packaging. (©Jakub Pavlinec/Dreamstime.com)



tremely rapid freezing of perishable foods in packages. Under the Birdseye system, fresh foods, from berries to lobster, were packaged snugly in convenient square containers. The packages were then pressed between refrigerated metal plates under pressure at very low temperatures.

General Foods used two types of freezing machines: the “double-belt” and “multiplate” Birdseye freezers. In the former, two metal belts held the food and were sprayed with calcium chloride brine as they ran through a 49-foot (15-meter) freezing tunnel. This type of freezer was used only in permanent installations and was soon replaced by the multiplate freezer, which was portable and required only about 124 square feet (11.5 square meters) of floor space, compared with the double-belt freezer’s 1,636 square feet (152 square meters).

The multiplate freezer made it possible to bring quick-freezing to seasonal crops. Such a freezer could be transported easily from one harvesting field to another to freeze crops such as peas fresh off the vine. This type of freezer consisted of an insulated cabinet equipped with refrigerated metal plates. Placed one above the other, these plates could be opened and closed to receive food products and to compress them with evenly distributed pressure. Each aluminum plate had internal passages through which ammonia flowed and expanded at a temperature of -3.8 degrees Celsius, thus causing foods to freeze.

A major benefit of the new methods of freezing foods was that the taste and vitamin content of most foods were not lost, as had been the case with previous methods. Ordinarily, when food is frozen slowly, ice crystals form within the food, slowly rupturing the cells and thus altering the taste of the food. In contrast, when food is frozen quickly at very low temperatures, cellular rupturing is minimized because the ice crystals formed are very small. Consequently, the food's texture, flavor, color, and odor are retained. Compared with slower freezing methods, quick-freezing also cuts down bacterial growth and retards oxidation in foods.

Up until 1925, financial problems plagued Birdseye's commercial efforts. Later, Wetmore Hodges, son of the vice president of the American Radiator Company, had the foresight to interest J. P. Morgan & Company in refinancing General Foods. By 1928, Hodges had convinced two other corporations that Birdseye's process had a sales potential of one billion dollars per year. Within the year, these companies negotiated the purchase of Birdseye's system, with its 168 patents. Soon, foods frozen using Birdseye's methods began to appear on the market under the trademark name Birdseye Frosted Foods. Birdseye, by then a millionaire, continued to act as a consultant to General Foods while promoting the frozen food industry by writing articles and presenting lectures on food preservation.

In later years, Birdseye turned his attention to developing an improved method of dehydrating foods, which he called "anhydrous." Relying on the same principle of speed that had served him well in the quick-freezing industry, he discovered that rapidly dehydrated foods retain their cell structure. His new quick-drying method extracted water from fresh-picked fruits and vegetables in one-tenth the time used by other methods and was said to retain color, flavor, texture, aroma, and nutritional qualities. This was Birdseye's second major contribution to the field of food preservation.

SIGNIFICANCE

During the months between one food harvest and the next, humankind requires trillions of pounds of food for sustenance. In many parts of the world, adequate supplies of a variety of foods are available all year long; elsewhere, much food goes to waste at some times and many people go hungry at others. Methods of food preservation such

as those developed by Birdseye have contributed immensely to reducing the number of malnourished in the world, as extending the season of availability of perishable foods increases the quantity and variety of foods that people can eat.

Economically, frozen foods quickly became and still remain important items of commerce. In a free market system, frozen foods compete successfully with fresh and canned foods. For consumers this means better foods at lower prices, whether fresh, frozen, or canned. The success of the frozen-foods industry also improved the fortunes of many related industries. For example, Birdseye's freezing methods revolutionized the shellfish industry, and even during the early twenty-first century some 90 percent of Iceland's export trade involves frozen fish. The prepared frozen foods industry came into being as a natural offshoot of the groundwork laid by General Foods.

Aside from the benefits of improved nourishment for many and economic growth, the industry that Birdseye fathered had a major impact on the lifestyles of many people, especially those in developed nations, as the time-saving option offered by frozen foods gave them more leisure time. In addition, the frozen-foods industry greatly increased the food choices available to people who live in even the most remote areas of the world.

Nancy A. White

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- SEE ALSO:** 1894-1895: Kellogg's Corn Flakes Launch Dry Cereal Industry; August 18, 1968: Congress Passes Wholesome Poultry Products Act.

■ MARCH, 1921

LENIN'S NEW ECONOMIC POLICY RETARDS RUSSIAN AGRICULTURE

The New Economic Policy changed the implementation of communism, allowing more private entrepreneurship and giving greater incentives to individual farmers and businesspeople.

LOCALE: Soviet Union

AGRICULTURAL ISSUES: Collectivization; Government policy and regulation; Land and land policy; Marketing and trade

KEY FIGURES

Vladimir Ilich Lenin (Vladimir Ilich Ulyanov; 1870-1924), leader of the 1917 Russian Revolution and founder of the Soviet Union

Joseph Stalin (Joseph Vissarionovich Dzhugashvili; 1878-1953), general secretary of the Soviet Communist Party, 1922-1953

Nikolay Ivanovich Bukharin (1888-1938), Soviet theorist and political leader

Grigory Yevseyevich Zinovyev (Ovsel Gershon Aronov Radomyslsky; 1883-1936), Bolshevik leader

Mikhail Tomskey (1880-1936), chairman of the Soviet Union's trade union organization

Leon Trotsky (Lev Davidovich Bronstein; 1879-1940), leading associate of Lenin who organized labor battalions to rescue the economy of the Soviet Union in 1920

SUMMARY OF EVENT

In early 1921, the Soviet economy was in a deep crisis. Forced collections of grain and centralized control of the economy helped the Red Army fight its enemy, but such tough measures led to widespread discontent among peasants, workers, and soldiers. Bolshevik leader Vladimir Ilich Lenin was forced to reject what was known as War Communism. In March, 1921, Lenin persuaded his colleagues Joseph Stalin, Nikolay Ivanovich Bukharin, Grigory Yevseyevich Zinovyev, and others to adopt the New Economic Policy (NEP) in an

attempt to stabilize the economy and to consolidate the Soviet regime. The NEP represented a retreat from radical policy. It reduced centralized control of the economy and gave farmers and small businesses access to the market. As a result, it helped Soviet economic recovery following the Russian Civil War. The NEP lasted for about seven years. It was finally rejected by Stalin in 1928, when he imposed an authoritarian central planning system.

During the early twentieth century, the Russian economy was predominantly agricultural rather than industrial, thus the treatment of peasants was a vital issue for any regime. When the Bolsheviks seized power after the October Revolution (1917), they had few specific plans concerning direction of the economy. Early economic measures amounted to little more than recognition of de facto developments. Nationalization of the land, the first measure, in effect recognized real peasant possession. Similarly, the decree on workers' control accepted that many factories had been taken over by workers. In December, 1917, the Supreme Economic Council was created, marking a significant step in establishing central control over the economy. The land decree became law in January, 1918. Under its provisions, land was to be in possession of those who used it. This was not a socialist measure but one that recognized the traditional Russian concept of ownership.

The seizure of power in the capital by the Bolsheviks was relatively peaceful, but the consolidation of power was a violent and difficult process. Civil war broke out in 1918 and lasted until 1921. The period of the civil war ushered in a new form of economic organization that became the precedent for a command economy. The demands of war gradually called forth more and more central control. Nationalization was extended to all industrial enterprises, trade was outlawed, and money essentially lost all its value. Market mechanisms were replaced by administrative orders. The main problem was securing food supplies for towns and for the army. A state grain monopoly had been introduced in February, 1918, but this proved unworkable as the money paid to peasants in return for their produce was virtually useless.

In May, 1918, a decree on grain control was issued with urgency. This decree called for compulsory delivery of all surpluses, over and above subsistence needs and seed, to the state. Any concealment

could lead to seizure without payment. Specific provision was made in the decree for the use of armed force if necessary. Clearly, the Soviet government was attacking the peasantry, although the attack was nominally only against rich peasants and participants in the black market. Armed workers and political police became involved in the collection of grain.

The basis of War Communism was the compulsory seizure of food-stuffs and their distribution without the market mechanism. The policy perhaps helped to win the war by keeping the army fed at least minimally, but it had negative consequences. Peasants reduced their planting to meet only their consumption needs, did their utmost to conceal their reserves from the requisitioning authorities, and occasionally responded to seizures with violent attacks on food collectors. Not only were peasants alienated by this policy, but a sharp decline in production also ensued.

Agricultural production fell by about 40 percent. Sown area was reduced, in passive response to grain seizure, by 34 percent from 1917 to 1920. Compared with production in 1913, yields of the major grains had fallen by more than 25 percent by 1920. Industrial production fell by 70 percent between 1913 and 1921, and that of heavy industry by nearly 80 percent. Coal extraction fell by 77 percent between 1913 and 1920. The results were serious famine and supply shortages. By the winter of 1920-1921, the civil war had essentially ended, and perhaps for this reason the resentment of the workers and peasants about the standard of living became stronger. The country witnessed a swelling tide of sporadic peasant uprisings; police counted 118 in February of 1921. Revolt was threatened in the countryside and workers rioted in the streets of Petrograd (St. Petersburg's new name). In March, 1921, sailors at the major naval base in Kronstadt mutinied, calling for economic reform and political change. There was urgent need for reform. In the same month as the Kronstadt rebellion, the Tenth Party Congress approved the ending of War Communism.

The economy of the Soviet Union was in ruins. Seven years of war and civil war had produced catastrophe. In 1921, industrial production stood at 13 percent of prewar volume. The grain harvest had fallen from 74 million tons in 1916 to 30 million tons in 1919 and continued to decline. At the Tenth Party Congress in March, 1921,

Lenin announced a series of measures that collectively became known as the New Economic Policy. The most important reversal of policy was the abandonment of forced requisitions in favor of a tax in kind that left peasants free to dispose of any surpluses that remained after the tax assessment had been met. The in-kind tax represented a determined effort to win back the favor of the peasantry. In order to persuade peasants to part with their surpluses, incentives had to be provided in the form of increased supplies of consumer goods. This made a revival of industrial production imperative.

Over the following months, the regime moved to restore private trade and to permit the establishment of small private industries and industrial cooperatives, in the hope that they could readily increase the flow of consumer goods. New enterprises were promised freedom from nationalization. Small enterprises that had been nationalized were leased to their former owners or industrial producers' co-operatives for fixed terms, with the provision that rents were to be



Vladimir Lenin addressing a public gathering in Petrograd (now St. Petersburg) in 1922. (Library of Congress)

paid in the form of a definite proportion of the output of the enterprise. In 1922, Lenin further allowed operation of small private farms as a means of adding to food production. Peasants were permitted to lease land and hire labor, although both the purchase and the sale of land were still prohibited.

Under the NEP, nearly 25 million peasants were permitted to farm their holdings on legally nationalized land and sell their produce after paying a tax to the state. Small-scale entrepreneurs were given a free hand in light industry and in the service trades. Small traders carried on the functions of buying and selling, sometimes through private trading concerns of their own, sometimes concealed as cooperatives, and not infrequently as official agents of the state trading organizations themselves. Although the food tax was prompted by basically political motives, it initiated the revival of the economy. The law provided that a peasant must pay the government a tax in kind consisting of a certain percentage, varying somewhat from region to region, of farm production. The peasant could then dispose of the remainder on the free market. In 1922, the tax was fixed at a standard 10 percent. By the Fundamental Law on the Exploitation of Land by the Workers, enacted in May, 1922, the government guaranteed peasants freedom of choice of land tenure. Land could be held individually, communally, or in other ways. Villagers thus were permitted, within rather broad limits, to manage their own economic lives as they saw fit.

Most of the land taken during the revolution was redistributed through peasant communes. The 1922 land code recognized the legal position of the land society, which in nearly all cases was the same as the traditional village commune. The land society was a community of households, usually within the same village, that performed an administrative function, exercised control over land use, and generally governed the farming program. The commune or land society organization became more extensive in the NEP period. Land formerly the property of the czarist state was for the most part taken over by land societies. In 1926, 83.4 percent of such land in the central industrial region and 61.7 percent in the central agricultural region was in land societies.

Under the New Economic Policy, private enterprise was encouraged, within set limitations, in the areas of agriculture, domestic

trade, light industries, and public services. The state, however, retained its monopoly over the so-called commanding heights: banking, heavy industries, transportation and communication, and foreign trade. Small businesses were granted a measure of economic freedom. Entrepreneurs were permitted to resume management of smaller concerns, to hire labor, and to trade more freely with the goods produced. The new class of small urban capitalists, however, suffered social pressures from which the peasants were exempt. It was difficult for them to obtain credit at banks, the rents on their apartments were often higher than their neighbors', and their children had to pay higher tuition fees at schools. Many of them expressed their suspicion that their situation was precarious and temporary by free spending and high living, taking advantage of liberties while they existed. The new era of "free enterprise" benefited not only the peasants and small-business owners but also individual workers. Trade unions, organized under the leadership of Mikhail Tomsky, were permitted to strike against the private capitalists. It was thought necessary that they be allowed to strike against state enterprises as well, even though they were urged not to do so and were reminded that by doing so they were by definition striking against themselves.

SIGNIFICANCE

The most important impact of the New Economic Policy was the transformation of state-market and state-society relations. Specifically, the Soviet state no longer saw all market relations as negative. The main features of the NEP were the abandonment of forced requisitions in agriculture and the substitution for them of a tax in kind, the toleration of private ownership in trade and small-scale industry, and the attempt to entice foreign capitalists into the Soviet Union in order to acquire their badly needed skills and capital. Replacing the policy of forced acquisition of grain with the tax in kind enabled farmers to sell their surplus food, giving a degree of market freedom to farmers. By allowing the operation of small private farms, the Soviet regime sought reconciliation with the peasantry. Many scholars have viewed the period of the NEP (1921-1928) as a relatively free period for agricultural and business activities under the Soviet government.

Under the new dispensation, the economy began to revive. Lenin told rank-and-file communists to “master trade.” State industries and state farms were commanded to show a profit and to operate on commercial principles. Financial stability was slowly recovered. By the end of 1922, a third of government revenue was coming from the food tax, another third from a variety of direct money taxes, and the final third from the issuance of bank notes. The New Economic Policy restored a considerable measure of capitalism to the Soviet economy, particularly in agriculture and trade. Lenin’s idea was that by this strategic retreat the Communist Party could keep control of the country but stimulate its recovery from the destruction and disorganization of the war years. Once the pressing problem of getting the economy functioning again was solved, the party could then resume its advance toward socialism.

Internal trade was conducted by state trading organs (which were relatively few), private traders, and cooperatives. Cooperative trading bodies were actively encouraged by the government and became relatively successful in the sale of consumer goods in rural areas. State-controlled trade was confined primarily to wholesale trade in urban areas. In Moscow in 1922, 83 percent of retail trade was in private hands and only 7 percent in state hands, whereas 77 percent of wholesale trade was handled by the state. In the NEP period, agriculture developed along capitalistic lines. The peasants paid taxes that, with the passage of time, became more and more monetary taxes rather than in-kind taxes. The land belonged to the state, but the peasants did what they saw fit with it. In seven years, agriculture reached levels that were unsurpassed in prerevolutionary Russian history. These levels would never again be reached in the Soviet system under the increasingly repressive agricultural policies pursued by Joseph Stalin.

Guoli Liu

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■ MAY 21, 1924

FARMERS DYNAMITE THE LOS ANGELES AQUEDUCT

Farmers in California's Owens Valley, angered by the drainage of their lands by the Los Angeles Aqueduct, resorted to the use of explosives when legal negotiations failed to achieve their goals in one of California's early battles over water.

LOCALE: Owens Valley, California

AGRICULTURAL ISSUES: Drought; Ecology and environment; Irrigation and water management

KEY FIGURES

William Mulholland (1855-1935), superintendent of the Los Angeles Department of Water and Power, 1902-1928

Joseph Barlow Lippincott (1864-1942), California supervisor for the federal Reclamation Service who concurrently contracted with the city of Los Angeles

Fred Eaton (1855-1934), city engineer who first envisioned an aqueduct from Owens Valley to Los Angeles

Mark Watterson (1876?-1948), Owens Valley banker who led opposition to the Los Angeles Aqueduct

Wilfred Watterson (1869?-1943), Owens Valley banker and Mark Watterson's brother and partner

SUMMARY OF EVENT

Owens Valley, located in central California, is one hundred miles long and ten miles wide, bordered on the west by the Sierra Nevada and on the east by the White Mountains and Inyo Range. This region was long well supplied with water from the Owens River, which ran the length of the valley from its headwaters in the High Sierras to alkaline Owens Lake. In 1913, however, the Los Angeles Aqueduct tapped this river and transported the valley's water 240 miles south to meet the growing needs of the city of Los Angeles. This was accomplished at the expense of Owens Valley farmers, ranchers, and townspeople, who found their livelihoods threatened.

MAY 21, 1924

Embittered by repeated attempts to come to terms with the Los Angeles Department of Water and Power (DWP) and its chief engineer, William Mulholland, and frustrated by court decisions against them, these citizens finally resorted to violent destruction to call the public's attention to their plight. On the morning of May 21, 1924, a group of forty men dynamited the aqueduct near Lone Pine. The damage was minimal and the action was largely symbolic, but this was only one battle in the twenty-year war waged over Owens Valley water. The Los Angeles Aqueduct's impact on valley commerce demonstrated the connection between business and natural resource utilization.

By the late nineteenth century, the Owens Valley was populated by miners, pioneers, Chinese laborers, and dislocated Paiute Indians. Homesteaders used the irrigation method previously practiced by the Paiutes. Canals and ditches diverted water from the Owens River, creating rich farmland from barren stretches of sagebrush. By the turn of the century, the Owens Valley was a prosperous agricultural region supporting farmers, ranchers, and the towns of Bishop, Independence, Lone Pine, and Big Pine. In 1903, the U.S. Reclamation Service (renamed Reclamation Bureau in 1923) studied the feasibility of a water system project in Owens Valley. Under the supervision of Joseph Barlow Lippincott, the project was designed to irrigate an additional 100,000 acres. Local citizens supported this plan and made potential reservoir sites readily available. Lippincott, however, also worked for Los Angeles during his employment with the Reclamation Service. According to William Chalfant, editor of the *Inyo Register*, Lippincott received five thousand dollars for providing the city with government maps and data. In 1905, he was accompanied on a valley survey by Fred Eaton, a Los Angeles city engineer.

Eaton first realized the potential for a gravity-powered aqueduct during a trip through the Owens Valley in 1892. His alliance with Lippincott enabled him to buy up about one million dollars' worth of land along the Owens River; he took advantage of the popular misconception that this property would be used for the reclamation project. The Reclamation Service decided not to pursue the project in view of the conflicting interests shown by Los Angeles city officials and businesspeople. Mulholland had known for years about Eaton's plan to bring Owens River water south, and by 1905 he was ready to initiate the aqueduct's construction. Southern California was suffer-

ing through the tenth year of a drought. Los Angeles's population had grown to 200,000 and was increasing rapidly. In July, the *Los Angeles Times* publicized the project for the first time. Angelenos were delighted. Owens Valley residents felt uneasy because the city failed to state a definite water development policy for the valley. Negotiations with the city met with resistance or bogged down in legal technicalities. The aqueduct was built with neither adequate storage facilities for excess floodwaters nor any guaranteed water supply for the Owens Valley.

The Los Angeles Aqueduct's gates opened on November 15, 1913. As the water rushed into the northern San Fernando Valley, Mulholland said to the crowd, "There it is—take it." To the delight of real estate speculators who had purchased land at two dollars per acre, this transported water turned the arid San Fernando Valley into an agricultural gold mine. The "unlimited" water also accelerated the pace of industrial and individual relocation to sunny Southern California.

For the next decade, Owens Valley residents attempted to coexist with the aqueduct, but another drought in 1921 caused the DWP to increase groundwater pumping in the valley. The water table fell, drying out farmlands adjacent to city-owned properties. Farmers tried to consolidate their position by forming irrigation districts. Their efforts were encouraged by Mark and Wilfred Watterson, owners of the Inyo County Bank. While other banks and institutions refused to deal with residents because of the valley's uncertain future, the Wattersons' bank took land mortgages and offered financial assistance.

Owens Valley residents' attempts to unify were broken up by city agents, who often resorted to misrepresentations. Angered by their coercive tactics, the farmers responded with violence. The blast of May 21, 1924, began an alternating pattern of destruction and negotiation. Over the next three years, and despite the presence of armed guards, the aqueduct was blown up eleven times. City wells were also dynamited. On November 16, 1924, a group of men led by Mark Watterson took over the Alabama Gates. They opened the spillway, causing aqueduct water to pour into the dry riverbed. During the next four days, an estimated five hundred to eight hundred valley residents picnicked and camped at the gates. To the protesters' disap-

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Section of the Los Angeles Aqueduct near Los Angeles. (©Ron Chapple Studios/Dreamstime.com)

pointment, the state militia was not called out, but the occupation received national sympathy.

Despite favorable attention from the press, the controversy continued for several years. The Owens Valley Property Owners Protective Association, led by the Wattersons, advertised grievances in state newspapers. It fought for financial restitution in the state's courts, where it won, and in the Senate Committee on Conservation, where a resolution died without a hearing. The final blow to the resistance movement occurred on August 4, 1927, when the state superintendent of banks discovered a shortage of funds at the Inyo County Bank. All five branches closed at noon, virtually wiping out the savings of Owens Valley residents. The Wattersons were tried and sentenced to ten years in San Quentin State Penitentiary.

SIGNIFICANCE

By the early 1930's, Los Angeles owned 85 percent of the Owens Valley. Although ranchers leased some city lands, their water rights were

not guaranteed and could be revoked at any time. The towns of Laws and Big Pine were abandoned. Bishop lost 35 percent of its 1920 population. Agricultural production dropped 84 percent between 1920 and 1930. Orchards were bulldozed, and fields of alfalfa gave way to sagebrush. The Owens Valley, once irrigated into agricultural fertility, reverted to its naturally barren state.

Initially, the aqueduct provided Los Angeles with a surplus of water. Adjacent communities were permitted to use the extra water in exchange for their annexation by the city. Businesspeople supported this plan because it increased real estate values and encouraged development. From 1915 through 1917, the city expanded from 108 to 350 square miles. The population increased from 200,000 in 1905 to 1,192,000 in 1925. To Mulholland's surprise, Los Angeles soon needed to look for another source of water.

The 1920's water war collapsed the economy of the Owens Valley, but the following fifty years saw the development of new business in tourism, recreation, and government employment. In 1941, the Long Valley dam granted Owens Valley a new lease on life. Crowley Lake, the reservoir created by the dam, became a recreational center for fishing and boating. Hikers, hunters, and skiers flocked to the Sierra Nevada and the White Mountains. Tourist dollars revitalized the valley towns' economies. City land no longer suitable for farming was consolidated into five-thousand-acre cattle ranches. Economic recovery, aided by jobs brought in by state and federal agencies, helped to triple the valley's population between 1930 and 1990.

When the Los Angeles Aqueduct was constructed, no laws prevented the transportation of water from one region to another. The Owens Valley controversy made the public aware that legislation applicable to water-rich states spelled disaster in California. In 1931, the state passed the "county of origin" law, which set guidelines for jurisdiction of water development, guaranteeing that local needs would be considered. No longer could those with money and power appropriate this vital resource.

The law was not retroactive, and so it affected neither the situation in the Owens Valley nor the Mono extension. As early as 1920, Mulholland considered adding sixty miles to the aqueduct to tap several streams feeding Mono Lake. This lake, although saline and with no outlet, was a unique biosphere supporting a network of insects

and birds. Following in the footsteps of their neighbors to the south, residents formed the Mono Basin Land Owners' Protective Association in 1931. Their protests fell on deaf ears, and in 1941 the city completed the extension. The lake level dropped slowly from 1941 to 1970, when a second aqueduct was constructed alongside the original one. The amount of water exported doubled within a few years. By 1981, the lake had fallen forty-six feet, and its surface area had receded from ninety to sixty square miles. In 1974, the environmental crisis at Mono Lake received public attention through the efforts of David Gaines, a biologist from the University of California, Davis. He formed the Mono Lake Committee in 1978 to inform the public and legally challenge the DWP. Although primarily an environmental group, the Mono Lake Committee empathized with the Owens Valley struggle and based its philosophy on the same principle of citizens protecting their natural resources.

Simultaneously, the environmental movement as a whole developed into a powerful force influencing business and political decisions. U.S. government policies began to reflect the public's concern with natural resources. Beginning in 1969, with creation of the Environmental Protection Agency (EPA) and passage of the National Environmental Policy Act, federal agencies took a larger role in setting guidelines and influencing state and local decisions regarding the development and allocation of resources. National policy had come a long way since 1906, when Theodore Roosevelt, pressured by Los Angeles businesspeople, put through a bill granting the city free access to federal lands along the aqueduct route.

The 1920's water war culminated in the economic upheaval of Owens Valley. Los Angeles drained water from the land without considering citizens' needs. Farms and ranches were sold or dried up. The towns depended on farmers for their economic livelihood and so lost much of their business. The valley managed to survive by making the transition from agricultural production to a service-oriented economy dependent on tourist dollars. The Owens Valley conflict became a California legend, and the story has been retold with varying accuracy in books and films. It showed how the exploitation of natural resources can devastate a region's commerce. The DWP's lack of forethought demonstrated the necessity of careful evaluation of present and future demands as well as environmental impact. Finally, al-

most one hundred years after the construction of the Los Angeles Aqueduct, an agreement was reached to return water to the Owens River, and water began to flow in December of 2006. A new era of revitalized ecology and recreational tourism was predicted, although the option to divert water back through the aqueduct to Los Angeles remained in place.

Susan Frischer

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tive action in a broad historical and sociological context. Well researched, informative, and objective, although esoteric and theoretically dense. Includes interesting photos, statistical tables, graphics showing the layouts of early towns, and comprehensive bibliography.

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■ 1927

U.S. FOOD AND DRUG ADMINISTRATION IS ESTABLISHED

With the establishment of the Food and Drug Administration, the U.S. government undertook the task of protecting consumers.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Chemistry; Diet, nutrition, and cuisine; Government policy and regulation; Pests and pesticides; Scientific research

KEY FIGURES

Walter Gilbert Campbell (1877-1963), head of the Food and Drug Administration, 1927-1944

George P. Larrick (1901-1968), commissioner of the Food and Drug Administration, 1954-1965

Harvey W. Wiley (1844-1930), first head of the U.S. Bureau of Chemistry

SUMMARY OF EVENT

The establishment of the U.S. Food and Drug Administration (FDA) grew out of a need to enforce regulations intended to protect the nation's food and drug supplies. The push for regulating food and drugs began soon after the United States was founded, when Massachusetts enacted a general food law in 1785. The first federal protection legislation came in 1848, when Congress passed the Drug Importation Act, which enabled U.S. customs inspectors to stop adulterated drugs from entering the country. During the second half of the nineteenth century, many new drugs appeared on the market containing unknown and questionable substances, including highly addictive ones such as morphine, heroin, and cocaine. Congress tried, unsuccessfully, to respond to the problem by introducing more than 190 bills between 1879 and 1906 to regulate food and drugs.

At the turn of the twentieth century, however, came renewed public interest in the conditions under which food was produced. As a re-

sult of Upton Sinclair's *The Jungle* (1906), which exposed conditions in the meatpacking industry, Congress passed the Pure Food and Drug Act in June, 1906. Enforced by the Bureau of Chemistry within the U.S. Department of Agriculture (USDA), the act made the interstate commerce of mislabeled or adulterated food, drinks, and drugs a federal crime. The act defined food as all substances used for food, drink, or seasoning for human or animal consumption; adulteration was defined as adding substances to reduce the quality or strength, hiding damaged conditions, or using filthy or diseased animals in production. Harvey W. Wiley, the USDA chief chemist who was also known as the father of the pure food movement, led the Bureau of Chemistry's efforts to enforce the 1906 act, although the act gave him no power to invoke fines or penalties.

Frustrated with the limitations of the 1906 act, Wiley retired from the Bureau of Chemistry in 1912 and was succeeded by Carl Alsberg. During the 1910's, the bureau struggled to enforce the law. Several cases reached the U.S. Supreme Court, including one in 1914 in which the Court ruled that the government needed merely to show that a substance might affect public health in order to declare it illegal. In 1921, attorney Walter Gilbert Campbell, who had been chief inspector of the Bureau of Chemistry since 1907, took over as the bureau's head.

Aware of the bureau's struggles to enforce the 1906 law, Congress began to consider creating a separate law-enforcement agency charged with administering the country's food and drug laws. With the creation of the Food, Drug, and Insecticide Administration (FDIA) in 1927, the country had its first regulatory agency dedicated to enforcing public health laws specifically related to food and drugs. Established as a separate agency under the Department of Agriculture, the FDIA became the Food and Drug Administration (FDA) in 1930. Under Campbell's direction, the agency addressed many problems in the food and drug industries and began to educate the public on nutrition and health.

In 1933, the New Deal policies of President Franklin D. Roosevelt led the FDA to recommend a complete revision of the 1906 law. Roosevelt demanded consumer protection for the millions of Americans struggling during the Great Depression and looked to the FDA to end questionable practices within the food and drug industries.

Unfortunately, it took a major public health threat to prompt Congress to enact a revised food and drug law. In 1937, the S. E. Massengill Company manufactured, without proper testing, a product called Elixir of Sulfanilamide for the treatment of sore throats. Almost twelve gallons were distributed before the FDA received notice of deaths attributed to the elixir. Upon testing, the FDA found the product to contain a highly toxic solvent related to radiator anti-freeze. Under the 1906 law, the FDA could do little, and more than one hundred people, mostly children, died.

This incident dramatized the desperate need for change, and strong prompting by the FDA led Congress to pass the Federal Food, Drug, and Cosmetic Act in 1938. With more than forty provisions, this act served as the nation's basic food law and as the basis for the FDA's actions. The law set food standards, placed cosmetics under regulation for the first time, and required that all new drugs be tested for safety. Moreover, the law gave the FDA the power to inspect factories and to seek the penalty of court injunctions. (The power to inspect without prior consent was added in 1953.) It was on the basis of this law and future amendments that the FDA established firm regulations to protect the country's consumers.

In 1940, the FDA moved from the Department of Agriculture to the Federal Security Agency, and Walter Campbell was named the first commissioner of the Food and Drug Administration. The FDA made two other moves over the next thirty years—to the Department of Health, Education, and Welfare in 1953 and to the Public Health Service under the Department of Health and Human Services in 1968. By the early twenty-first century, the agency had nine thousand employees working at offices or inspection posts in nearly 170 cities. FDA personnel conducted about sixteen thousand visits annually to facilities under its oversight.

In 1988, the Food and Drug Administration Act officially established the FDA as an agency of the Department of Health and Human Services, with a commissioner appointed by the president with the advice and consent of the Senate. This act also broadly listed the responsibilities for the commissioner in four major areas: research, enforcement, education, and information. All responsibilities were related to the primary goal of protecting the country's food and drug supplies.

SIGNIFICANCE

The FDA's many responsibilities were geared toward protecting the food, drugs, and cosmetics available to U.S. consumers. By establishing quality standards and conducting periodic inspections, the agency helped companies comply with the complicated regulations governing food, drug, and cosmetic production. Every substance that went into a product—from pesticides used to control insect problems in the food industry to color additives in cosmetics—came under FDA control. The FDA also worked to ensure that foreign products sold in the United States were produced under sanitary conditions. In addition, the FDA served as an information resource for American consumers regarding the quality of thousands of products. Through consumer consultants and publications such as *FDA Consumer* and *FDA Drug Bulletin*, the agency brought information as well as warnings to the public's attention. The FDA also used the media to prevent illness from widespread contaminations such as those that often follow natural disasters.

Even after the 1938 law provided increased options for the FDA, the agency continued to be hampered by limitations. FDA regulation applied only to interstate commerce; food prices, advertising, and mailed food products did not fall under FDA control, and meat and poultry were controlled by another agency. After 1938, once a violation was determined to have been committed, several options were available to the agency, including recalls, seizures, fines, and injunctions. Until 1985, the maximum fine was \$1,000 for misdemeanor violations and \$10,000 for felony violations. After federal revisions, the maximum fine was raised to \$100,000 per offense and \$250,000 for a felonious offense or one that resulted in death. Corporations faced fines twice as high. Noting an increase in criminal violations during the late 1980's, the FDA opened the Office of Criminal Investigations to deal with criminal offenses.

Passage of the 1938 Food and Drug Act received little public attention. World War II brought several technological advances that companies wanted to carry over into consumer use, however, many products and substances needed FDA approval. Under Commissioner George P. Larrick, the FDA worked to set strict regulations and research guidelines to protect consumers. During the 1950's, the agency increased its regulation of food production. In 1954, Con-

gress passed the Pesticide Amendment, which gave the FDA the power to set and enforce pesticide tolerances in foods. (The newly created Environmental Protection Agency took over this area in 1970.) The Food Additives Amendment in 1958 charged the FDA with establishing the proven safety of all chemical additives before they were used in food. One year later, the “Generally Recognized as Safe,” or GRAS, list appeared, which included the most common substances used in food production—including salt, pepper, sugar, and vinegar—that were permissible and excluded from testing. That same year, the Delaney Clause to the 1938 act prohibited the use of substances if they were proven to be carcinogenic in animals. With the addition of the Color Additives Amendment in 1960, no substance could be put into the U.S. food supply without first being determined safe. The responsibility to prove safety fell on the producers, and the responsibility for policing the producers fell on the FDA. During the 1960’s, several problems with the manufacture of baby food and infant formula showed that companies could not be relied upon to police themselves. As a result of these problems, the FDA pushed for the 1980 Infant Formula Act and its 1986 amendment, which strengthened quality standards and established recall procedures.

In addition to developing strict guidelines for approving substances for use in food, the FDA also recalled some products after they had been approved. In response to new medical information regarding cancer, the FDA removed such products as cyclamates and saccharin from the food supply. When necessary, the agency also responded to concerns about contaminated seafood and other products.

The FDA also worked to educate the public about good nutrition. The labeling of food proved to be an integral part of raising public awareness. Food labels had been under federal control since 1906, but they became more important during the 1980’s. Increased public attention to fitness caused the FDA to lower the recommended diet to 2,000 calories per day in 1980. In addition, the FDA and the Department of Agriculture revised the recommended diet from the “basic four” food groups to the “food pyramid” of the 1990’s. The 1990’s also brought new FDA guidelines that required uniform labels on all food products and defined such food-related terms as “lower,” “light,” and “free.”

The FDA provided consumers and doctors with the security that

drugs were safe and uniform. With the emergence of a number of chemicals during World War II, pharmacology became a vital field of medicine and one that relied on the resources of the FDA. Antibiotics appeared as a direct result of World War II, and the FDA responded by requiring the certification of five different antibiotics by 1949, including penicillin and streptomycin. Manufacturers were required to test for efficacy and to keep distribution records so that entire batches could be recalled if necessary. Soon after, companies were required to keep distribution records of all drugs. The importance of this policy was demonstrated in 1982, when the pain reliever Tylenol was linked to several poisoning cases and had to be recalled. Safety also came into play during the early 1960's when the drug thalidomide, which had been widely used in Europe throughout the 1950's as a supposedly safe sedative and antinausea treatment for pregnant women, came to the FDA for approval. Frances Kelsey, who was assigned to review the drug, learned of an association between the use of thalidomide and deformed babies and was instrumental in keeping the drug off the U.S. market.

The FDA also controlled the distribution of drugs by determining which products would be available by prescription only—after 1952, these carried the warning “Caution: Federal law prohibits dispensing without prescription”—and which would be available over the counter. Several drugs previously available only by prescription started appearing in over-the-counter versions when the FDA established new guidelines during the 1970's. The 1980's also saw a dramatic increase in the availability of generic drugs, for which the FDA provided strict guidelines.

Despite all the FDA's efforts to monitor the drug industry, problems throughout the 1940's and 1950's pointed to a loophole in the 1938 law. Although manufacturers were required to prove safety, they were not required to prove effectiveness. Many “safe” products were consequently approved even though they were not effective. Congress investigated the issue during the early 1960's, and in 1962, reforms were passed that required all new drugs to prove both safety and effectiveness. The reforms also called for manufacturers to report the benefits and risks of their products to the FDA and medical professionals, and the FDA was charged with evaluating the drugs approved between 1938 and 1962 for effectiveness.

During the 1980's and early 1990's, two unrelated issues, acquired immunodeficiency syndrome (AIDS) and breast implants, brought increased pressures on the FDA. Throughout the 1980's, critics and AIDS activists charged the FDA with being too slow to test and release drugs. The FDA did not approve an AIDS test for blood until 1985. Frustrated with the delayed approvals, AIDS sufferers often turned to fraudulent "cures" and highly unpredictable experimental procedures available in other countries. The FDA also came under fire for problems with silicone breast implants. The Medical Device Amendments of 1976 had provided the same guidelines for these devices as for drugs; another measure in 1990 compelled hospitals and other medical facilities to report any problems with medical devices that resulted in serious illness, injury, or death. These amendments came under heavy criticism when silicone breast implants were found to be dangerous during the early 1990's. Many again thought that the FDA had moved too slowly in response to the issue.

The FDA has unquestionably had a tremendous effect on American life. Protecting the products that account for more than 25 percent of a consumer's budget, the FDA has worked to ensure that those products are safe and of the highest quality. Once it had been given power to enforce the country's food and drug laws, the agency made significant advances in ending questionable practices that could harm public health.

Jennifer Davis

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■ JUNE 15, 1929

AGRICULTURAL MARKETING ACT BECOMES U.S. LAW

The Agricultural Marketing Act of 1929 established the Federal Farm Board to make loans to farm cooperatives and to control surpluses of farm commodities.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Government policy and regulation; Marketing and trade; Price supports and controls

KEY FIGURES

Herbert Hoover (1874-1964), president of the United States, 1929-1933

Alexander Legge (1866-1933), American businessman and first chairman of the Federal Farm Board

Arthur M. Hyde (1877-1947), U.S. secretary of agriculture

Charles L. McNary (1874-1944), U.S. senator from Oregon

Gilbert N. Haugen (1859-1933), U.S. congressman from Iowa

SUMMARY OF EVENT

In order to understand the impact of the Agricultural Marketing Act of 1929, it is necessary to understand what happened to the American farm sector early in the twentieth century. The second decade of the twentieth century was a good one for farmers. The world had experienced rapid industrial expansion, causing incomes and spending to rise. Demand for agricultural commodities had expanded, giving farmers high prices for their crops. Farmers in the United States were producing large crops and exporting large parts of them to foreign markets. A fixed quantity of good agricultural land caused land prices to go up, making farmers feel wealthier. It appeared that this prosperity would continue indefinitely.

Things began to change in 1919, however. European farmers were producing more as they recovered from World War I, and prices started to fall. In 1921, wheat and cotton were selling for half their 1920 prices, and American farmers realized that hard times had re-



Poster prepared by the U.S. Food Administration in 1918 to encourage Americans to increase their consumption of corn and corn products. (Library of Congress)

turned. By 1923, agricultural commodity prices had started to rise slowly, and farm conditions began to improve. Things were getting better, but conditions for farmers still were unfavorable. Mechanization of farmwork promised to help farmers by cutting production costs but was soon to contribute to problems of overproduction.

Agriculture was an important sector in the U.S. economy during the early 1920's, and Congress believed that help was needed for farmers, even though farm prices were edging up after the drastic drop during the early 1920's. A major attempt to help was embodied in the five bills introduced in Congress from 1924 to 1928 by Senator Charles L. McNary of Oregon and Congressman Gilbert N. Haugen of Iowa. The McNary-Haugen bills called for an export corporation that would purchase agricultural crops in amounts large enough to keep their prices at acceptably high levels. These purchases were not to be sold domestically but were to be sold in foreign markets. The bills also called for an import tariff to discourage foreign farmers

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from sending agricultural goods to the United States to compete with domestic products. The first three McNary-Haugen bills did not pass Congress. The last two bills passed Congress but were vetoed by President Calvin Coolidge. Herbert Hoover, Coolidge's secretary of commerce, was influential in advising Coolidge to veto the bills.

The Agricultural Marketing Act of 1929 differed from these bills in that it focused on improved marketing as a means of aiding farmers. The government, under this act, would encourage formation of national cooperative marketing organizations but would not run them.

As director of the U.S. Food Administration and as secretary of commerce, future president Hoover had participated in the many agricultural policy debates of the late 1910's and the 1920's. In 1928, he campaigned for president, promising to call a special session of Congress to deal with farm problems. Hoover had grown up on an Iowa



Members of the Federal Farm Board meeting in July, 1929, shortly after the board was created. Chairman Alexander Legge is seated at the center, at the head of the table. (Library of Congress)

farm and believed that an improved marketing process was the solution to the farm problem. Despite his strong feelings about the issue, once in the office of president he sent no specific legislation of his own to Congress, not wanting to interfere with Congress's legislative prerogative. Even so, Congress had a good idea what Hoover wanted. It passed the Agricultural Marketing Act, which became law on June 15, 1929.

The overall goal of the act was to put agriculture on an equal footing with other business sectors in the country. The objectives specified to carry this out were to decrease agricultural surpluses, stabilize prices for agricultural commodities and thereby cut down on speculation, and provide help in marketing of agricultural commodities. The act called for the establishment of the Federal Farm Board, which was to have a budget of \$500 million.

The Federal Farm Board was directed to set up national farmer cooperatives as a means of achieving its goals. These cooperatives were to be controlled by farmers and were to be used primarily to improve the marketing of crops. It was believed that the coming together of farmers into a comprehensive organization that could bargain on behalf of farmers would give farmers the power to prevent drastic price declines. The Federal Farm Board was authorized to make loans to the cooperatives to increase their size and efficiency. These loans could be used to build new facilities or for expenses of marketing agricultural crops. Farmers could obtain loans at low rates of interest.

President Hoover persuaded Alexander Legge to leave his \$100,000-per-year job as chairman of International Harvester to become the first chairman of the Federal Farm Board. Seven other board members were appointed, representing the major farm commodities. Arthur M. Hyde, as Hoover's secretary of agriculture, was an ex officio member.

By October of 1929, the Federal Farm Board had succeeded in setting up the Farmers National Grain Associations, which were stock companies in each of the major commodities. Stock in the associations was owned by the larger local grain cooperatives. The goal of each of these corporations was to become a large, centralized organization to facilitate marketing for the particular commodity it represented. It was hoped that their sheer size and the coordination of the marketing process they offered would increase the efficiency of mar-

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keting agricultural crops, thus stabilizing prices at the desired high levels. The National Grain Associations were also supposed to control agricultural surpluses. Unfortunately, the government also had in place county extension agents, whose job was to help increase production. Getting farmers to control production was difficult, and the Federal Farm Board never succeeded in this task. The government thus, to some extent, operated at cross-purposes, trying to keep prices high while also encouraging production.

SIGNIFICANCE

In 1930, the Federal Farm Board decided that its efforts were not succeeding. A surplus of major commodities kept agricultural prices low. Several factors contributed to the surpluses. The United States and Europe had had a few years of abundant harvests, and other countries were restricting imports from the United States and imposing tariffs in retaliation for the Hawley-Smoot Tariff of 1930. Farmers were particularly hurt by these retaliatory tariffs because they had long used exports as a means for eliminating agricultural surpluses. Finally, the Great Depression caused everyone to suffer. Low incomes meant that people were buying less of everything, including farm products.

The surplus in wheat was particularly troubling. Wheat prices fell dramatically, and in response the Federal Farm Board set up Grain Stabilization Boards in February of 1930. These boards hoped to control grain prices by encouraging farmers to reduce their output. Chairman Legge of the Federal Farm Board and Secretary of Agriculture Hyde toured the country trying to get farmers to participate in the production control process. They were unsuccessful in getting farmers to cooperate with these programs, so the Grain Stabilization Boards started buying surplus wheat. The purchase program was intended to be temporary, as no one recognized that the Great Depression was going to last for many years. Grain prices continued to fall, and by 1931 farm incomes were at the lowest levels of the century. The Federal Farm Board decided that it could no longer afford to buy grain or to store the grain it had already purchased. Fearing that the grain already purchased would rot in storage, the Federal Farm Board began to sell the grain it owned. This had a further dampening effect on prices and enraged farmers. The public outcry against the

sale was so large that Legge resigned as chair of the Federal Farm Board.

The national cooperatives never emerged as the force that Hoover had hoped they would be. They were poorly managed and suffered from the same inefficiencies as the rest of the agricultural sector. They had little lasting effect on American agriculture, and most of them did not survive to the end of the 1930's.

The price stabilization portion of the Federal Farm Board's efforts fared no better than did the national cooperatives. The Federal Farm Board found that it could not stop the slide in agricultural prices by buying surplus grains, as illustrated by the case of wheat. Not only did it fail to keep prices from going down, it spent \$400 million in taxpayers' money and disrupted commodity markets. Stabilization was a relatively new idea that was to be used in later legislation; some credit needs to be given to the Federal Farm Board for innovative thinking.

Production controls similarly failed. Hoover thought that if farmers voluntarily cut back on production, surpluses could be eliminated. Legge and Hyde toured the country to try to get farmers to cooperate with this plan. Primarily because the plan was voluntary, farmers did not participate in it. The Federal Farm Board made a special report to Congress in late 1932 in which it stressed that farm policy should include a system that would control the acreage planted. Future farm legislation made this recommendation part of production control programs.

Hoover did not recognize immediately that his farm plans were not working, so no adjustments to the plans were made during his presidential administration. His top farm advisers, Legge and Hyde, shared Hoover's vision of how to help the farmers and so did not offer alternative plans. In Hoover's defense, it is likely that the McNary-Haugen plans introduced during the 1920's would not have fared much better. The onset of the Great Depression, coinciding with increased production made possible by the mechanization of farm production, made the Federal Farm Board's goals nearly impossible to achieve.

Hoover had high hopes for solving farm problems with voluntary participation by farmers. He had seen what had happened to farmers in the Soviet Union and did not want the government to intervene on such a large scale. Farmers did not choose to participate in Hoo-

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ver's plans, however, and even if they had, the low budgets available to the Federal Farm Board doomed the stabilization plans to failure.

Congress became disenchanted with the Federal Farm Board and cut its 1932-1933 budget by 60 percent. Hoover lost the 1932 presidential election to Franklin D. Roosevelt, who had his own ideas about what should happen in the farm sector. Roosevelt abolished the Federal Farm Board in 1933, effectively ending the influence of the Agricultural Marketing Act of 1929. In 1933, Congress passed the Agricultural Adjustment Act, which was the New Deal's attempt to help farmers.

By 1935, farm income was 50 percent higher than it had been in 1932. Key elements of the 1933 act were declared unconstitutional in January, 1936, and later that year, new farm legislation was passed. As was suggested by the Federal Farm Board, production controls were a key element in the new plans.

Eric Elder

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■ DECEMBER, 1932-SPRING, 1934

SOVIET AGRICULTURAL POLICIES PRODUCE GREAT FAMINE

In the Soviet Union, forced collectivization and the seizure of foodstuffs by the central government resulted in the deaths of millions of peasants. Huge numbers of people were either murdered outright or died as a result of horrific conditions in state-run camps, although Joseph Stalin's government attempted to hide its crimes from the world.

ALSO KNOWN AS: Terror Famine

LOCALE: Ukraine, Russia, Kazakhstan, and the Soviet Union's North Caucasus regions

AGRICULTURAL ISSUES: Collectivization; Famine and hunger; Government policy and regulation

KEY FIGURES

Joseph Stalin (Joseph Vissarionovich Dzhugashvili; 1878-1953), general secretary of the Communist Party in Russia and dictator of the Soviet Union, 1929-1953

Nikita S. Khrushchev (1894-1971), Soviet leader in the Ukraine

Pavlik Morozov (1918-1932), one of many young people who informed on their parents at the behest of the Soviet state

SUMMARY OF EVENT

In October of 1928, Soviet dictator Joseph Stalin rolled out the First Five-Year Plan for the Soviet Union's economic transformation. The plan promised to ensure the comprehensive development of industry throughout the Soviet Union and included a plan to modernize Soviet agriculture, which remained largely unchanged from its days under the czars: Most peasants still lived in small villages and followed traditional methods of agriculture.

The Five-Year Plan was supposed to transform Soviet peasants into an agricultural proletariat. Although some would become direct employees of state-owned farms, the rural equivalent of factories, the majority were expected to join cooperative enterprises known as col-

lective farms, in which they would pool their tools and labor and share in the proceeds. These new farms would be provided with modern farm machinery that would help bring Soviet agricultural productivity in line with that of industrialized Western nations.

In theory, the transition was supposed to be voluntary, and a great deal of publicity was devoted to the first few peasants who joined. However, only the poorest of peasants stood to gain anything under the new arrangement, and so most simply ignored the call to collectivize. Many resisted the government's attempts to compel their participation.

Stalin's response to attempts at resistance was brutal and coercive. The prosperous peasants, often known as kulaks (the Russian word for "fist"), were condemned as enemies of the people. Another group, known as subkulaks, was theoretically composed of peasants too prosperous to be grouped among the very poor and not prosperous enough to be kulaks, although in reality this group included anyone who objected to collectivization. Kulaks and subkulaks were arrested in huge numbers and sent to prison camps in obscure regions of Siberia, where many began building their own camps immediately after disembarking from the deportation trains. Thousands died of exposure within days of their arrival: Prisoners often wore nothing but the clothes they had on at the time of their arrest in the far warmer lands of Ukraine and the northern Caucasus.

Many of the peasants who were not arrested were accused of hoarding food. Arbitrary production quotas from the central planning agencies were enforced by the secret police, whose members operated under the assumption that peasants had plenty of food and that they were simply hiding it from the government. Agents regularly broke into peasant huts and barns to take whatever they found, and in response desperate peasants sought food wherever they could, often picking fallen grain from the fields. Stalin reacted by promulgating even harsher laws. A person could be shot for "stealing" as little as five heads of wheat. The mere possession of grain, even if it was being stored for the next year's planting, was considered evidence of hoarding, and the accused were often executed without even the pretense of a trial.

Children were encouraged to inform on their parents for hoarding grain or for otherwise resisting collectivization. The most famous



Uzbeki farmers discussing their sowing work on a Soviet collective farm. (Library of Congress)

case was that of Pavlik Morozov, a fourteen-year-old member of the Young Pioneers (the state-sanctioned youth organization) who turned in his father—who had been the head of the village soviet in Gerasimovka—and was subsequently murdered by a group of villagers led by his uncle. The Soviet government quickly made Morozov a martyr and erected a shrine to him in the house where his father's trial had been held. Stalin's background as a former seminarian was perversely expressed in the development of the cults centered on Morozov and others like him, including Kolya Myagotin, Kolya Yakovlev, Kychan Dzhalkylov, and Promya Kolibin. At least one mother who lost her son in the collectivization and resulting famine said that she would rather see her child killed than have him twisted into the type of person who would betray family to the government.

Whole families perished during the artificial scarcity: Some collapsed from exhaustion while in search of food, while others died quietly in their huts. Starving peasants who searched for food in the towns and cities were turned away, and some became so maddened by hunger that they filled their bellies with anything remotely edible, including tree bark and grass. Others were so desperate that they

turned to preying on their fellow human beings, eating what little flesh remained on the bones of those who had already starved or murdering people outright. Nikita S. Khrushchev's memoirs grimly recounted the author's memory of finding a peasant woman ranting that she had already eaten her daughter and was now salting her son's flesh.

In March of 1930, Stalin issued a proclamation called "Dizzy with Success," a tactical retreat in which he criticized the "excesses" of collectivization, but this meager action did little to slow famine's rising tide, and the disruption of agriculture and widespread starvation continued for several years. Furthermore, Stalin refused to seek international aid and determinedly concealed the famine's extent. Western democracies were largely unaware of the massive numbers of deaths; Stalin did not want to give the world powers reason to doubt the First Five-Year Plan. In order to prevent the unauthorized flow of information, Stalin established strict controls on travel, and any contact between Soviet and foreign citizens was automatically suspect.

SIGNIFICANCE

Forced collectivization and the resulting famine dealt huge blows to Soviet agriculture. Agricultural productivity plummeted just as the Soviet Union was most in need of food to fuel the industrialization imposed by the First Five-Year Plan. Production would not return to precollectivization levels until 1940, just before the Nazi invasion inflicted further destruction on the Soviet Union's principal agricultural regions. The problems at the root of the Soviet systems of collective farming and central planning prevented the country's agricultural advancement and made it permanently incapable of feeding its citizens. Even Soviet president Mikhail Gorbachev's 1980's-era program of perestroika (restructuring) proved incapable of remedying the situation. Furthermore, Stalinist policies discouraged farmers' attempts to take any initiative, and this legacy continued to plague Russian farmers after the Soviet Union's fall.

The famine's human cost was enormous but could not be acknowledged under Stalin's inflexible policies. Noted Soviet writer Boris Pasternak suggested that the 1936-1937 Great Terror, in which thousands of Soviets suspected of opposing Stalin were killed, was the

direct result of collectivization's failure: Because the catastrophe of collectivization could not be acknowledged, Soviet citizens were taught to ignore the evidence of their own experience and believe what they were told. This absurd situation spawned show trials in which the Bolshevik Revolution's founding fathers confessed to outlandish accusations that they had spied for foreign governments and had conspired to destroy the government that in reality they had risked everything to create.

Leigh Husband Kimmel

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■ OCTOBER 18, 1933

FEDERAL GOVERNMENT BEGINS FARM PRICE SUPPORTS

A New Deal program established by Franklin D. Roosevelt's executive order, the Commodity Credit Corporation was a supplement to the crop reduction program of the Agricultural Adjustment Act of 1933 that would become the major instrument for implementing government farm price supports.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Marketing and trade; Price supports and controls

KEY FIGURES

Franklin D. Roosevelt (1882-1945), president of the United States, 1933-1945

Charles W. Macune (1851-1940), leader whose subtreasury plan foreshadowed the Commodity Credit Corporation

Herbert Hoover (1874-1964), president of the United States, 1929-1933

Lynn P. Talley (1881-1942), Texas banker, president of the Commodity Credit Corporation from 1933 to 1940

Henry A. Wallace (1888-1965), U.S. secretary of agriculture, 1933-1940

Jesse H. Jones (1874-1956), chairman of the Reconstruction Finance Corporation from 1933 to 1945

Harry S. Truman (1884-1972), president of the United States, 1945-1953

SUMMARY OF EVENT

The agricultural sector of the U.S. economy began a decline during the early 1920's, and the general slump in the economy following the stock market crash in the fall of 1929 aggravated the situation. The crux of the farm problem was overproduction. Crops that exceeded domestic demand pushed prices down to the low levels prevailing in world markets. The solution adopted by President Franklin D. Roosevelt and incorporated in the Agricultural Adjustment Act of 1933 was

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the Voluntary Domestic Allotment Plan. The idea was to reduce production so that prices would rise to parity, a level at which each commodity would have the same purchasing power as it had during the period from 1909 to 1914. The mechanism for achieving that goal was to pay farmers who agreed to limit the number of acres they cultivated. The program covered seven basic commodities: wheat, cotton, corn, hogs, rice, tobacco, and milk. Later additions to the list included rye, flax, barley, grain sorghum, cattle, sheep, peanuts, sugar beets, sugarcane, and potatoes.

Farmers had long complained about short-term fluctuations in prices. Most farmers had to sell their crops at or soon after harvest, when prices were artificially depressed by the influx into the market. At the same time, the Roosevelt administration was under heavy pressure to do something to give an immediate boost to agricultural prices and put cash into farmers' hands. In response, Roosevelt's Executive Order 6340 of October 18, 1933, established the Commodity Credit Corporation. The agency had \$3 million that could be used to make low-interest loans available to farmers so that they could hold their crops off the market. The loans, however, were to be limited to those who signed the Agricultural Adjustment Administration (AAA) acreage limitation contracts. These were nonrecourse loans, meaning that if the market price rose above the loan level, the grower could repay the loan and sell the crop. If the price fell below the loan level, the grower could have the loan canceled without liability; the Commodity Credit Corporation would take over the crop and thus bear the loss.

The roots of the Commodity Credit Corporation lay in the farm protest movements of the late nineteenth century. Many of the protesters blamed the decline in farm prices, which began during the 1870's, on an insufficient supply of money. Failure of the money supply to expand to meet the needs of a growing economy was in turn blamed on the gold standard. A popular solution recommended that the money supply—and thus farm prices—be inflated by the issue of paper money.

The most ambitious of those proposals was the "subtreasury" plan advanced during the late 1880's and early 1890's by Texas farm protest leader Charles W. Macune. Macune proposed that every county in which a minimum of \$500,000 worth of agricultural produce was

Federal Government Begins Farm Price Supports



Cows lined up in a Massachusetts dairy farm during the mid-1930's. The dairy industry was particularly strongly affected by the federal price-support program.
(Library of Congress)

sold a year should have a subtreasury office along with crop storage facilities. Farmers who brought in their crop for storage would be advanced 80 percent of the local price in paper money at an interest charge of 1 percent a year, on the condition that the produce be redeemed or sold at auction within one year. Support for the plan faded even among farmers because of the appeal of William Jennings Bryan's call for free silver as the solution to the money-supply problem.

The more direct antecedents of the Commodity Credit Corporation lay in the agricultural programs introduced by President Herbert Hoover. The major thrust of Hoover's solution to the farm problem, incorporated in the Agricultural Marketing Act of 1929 and administered by the Federal Farm Board, was government assistance to promote better-organized and more orderly marketing of agricultural products through larger and stronger cooperative marketing associations. The cooperative marketing associations set up under the new law, such as the Farmers National Grain Corporation and the National Wool Marketing Corporation, included programs in which farmers could receive an advance on delivery of their crop for later resale. A tool meant to iron out short-term fluctuations in price, the legislation provided for the establishment of "stabilization corporations" that would purchase farm products at harvest time and would resell them when prices rose. When prices for cotton, corn, and wheat fell sharply after the stock market crash, the stabilization cor-

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porations made large-scale purchases in a futile bid to sustain prices. The resulting losses exhausted most of the \$500 million revolving fund allotted to the Federal Farm Board and forced suspension of stabilization corporation purchases.

The Commodity Credit Corporation was a continuation of the Federal Farm Board's stabilization corporations, but with more generous funding. Its \$3 million in start-up capital was supplied by the secretary of agriculture and governor of the Farm Credit Administration from funds provided by the National Industrial Recovery Act (1933). During its early years, however, most funding came as loans from the Reconstruction Finance Corporation (RFC). Although technically a corporation organized under the laws of Delaware, the Commodity Credit Corporation was largely administered as an RFC subsidiary. Lynn P. Talley, a Texas banker who was a longtime friend of Jesse H. Jones, chairman of the RFC, was made president of the new agency and retained that position until health problems forced his retirement in early 1940.

Under Roosevelt's 1939 reorganization of the executive branch, the Commodity Credit Corporation became a part of the Department of Agriculture and was wholly responsible to the secretary of agriculture. Although Congress placed the Commodity Credit Corporation on a statutory basis in January, 1935, the agency continued to depend on periodic renewals of its authorization until June, 1948, when Congress gave it permanent status.

Although the Commodity Credit Corporation had authority to make loans directly to farmers, few were made in that fashion. The agency's managers preferred to encourage private banks to extend loans by guaranteeing that the Commodity Credit Corporation would, on demand, buy all such loans. Even this guarantee failed to overcome private bankers' nervousness about the soundness of farm loans, however, and as a result, most of the loans were made by the Commodity Credit Corporation itself, with private lending agencies acting only as brokers. Thanks to the strength of the farm bloc in Congress, the agency had even larger amounts of money to lend, and its capital was raised to \$100 million in 1938. More important, lawmakers repeatedly increased its authority to borrow on the credit of the United States: Farmers could borrow \$900 million in 1939, \$1.4 billion in 1940, \$2.65 billion in 1941, and \$10 billion by 1954. The Ag-

ricultural Adjustment Act of 1938 shifted the major thrust of the Commodity Credit Corporation from ironing out short-term fluctuations in supplies and prices to a new goal of maintaining farm prices above their free-market levels. The agency's mission thus became one of subsidization rather than stabilization.

The Commodity Credit Corporation's first major loan undertaking, the corn program of 1933-1934, proved successful because of a drought that caused a sharp reduction in the size of the 1934 corn crop and therefore increased the price per bushel. Most of the loans were repaid, and the Commodity Credit Corporation even made a profit on the operation. This success inspired Secretary of Agriculture Henry A. Wallace to urge a permanent commodity-loan program for maintaining an ever-normal granary—that is, stabilization of supplies and prices through loans that allowed farmers to withhold part of their crops from the market in years of high output and release them in years of short production.

The ever-normal granary idea was a handy rationale for permanent establishment of the Commodity Credit Corporation. The decisive factor in its transformation into the major instrument for long-term farm price maintenance was the failure of the production-limitation program of the Agricultural Adjustment Act of 1933 and its successor, the Soil Conservation and Domestic Allotment Act of 1936. This failure was partly the result of the lack of voluntary cooperation from farmers and partly the result of contract violations by cooperating farmers. The major difficulty faced by the corporation was that advances in technology were rapidly increasing output per acre.

When the Agricultural Adjustment Act of 1938 was written, Farm Belt lobbyists managed to include directing the Commodity Credit Corporation to make mandatory nonrecourse loans on a number of crops whenever their prices fell too low or their production rose too high. Such loans were available only to those who cooperated with the legislation's acreage limitation program, in which the major crops were cotton, corn, and wheat. As of 1940, however, the Commodity Credit Corporation was making loans on butter, dates, figs, hops, mohair, peanuts, pecans, prunes, raisins, rye, tobacco, turpentine and rosin, and wool. Congress also repeatedly raised the loan rate and offered higher guaranteed prices.

Given the continued failure of meaningful production limita-

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tions, the net effect was to give farmers a virtually blank check from the treasury, and the Commodity Credit Corporation accumulated increasingly large collections of stocks and commodities as more and more farmers defaulted on their loans. The carryover of cotton, for example, reached an all-time high of 13.3 million bales in 1939, more than a full year's supply for both domestic use and export. The carryover of corn rose to a record level of 687 million bushels in 1940, more than double the carryover of the early 1930's. Only World War II prevented what appeared to be the impending collapse of the farm-price support system.

As the price of allowing the imposition of wartime price ceilings on farm products, the farm bloc in Congress wrote into the Stabilization (Anti-inflation) Act of October, 1942, a provision requiring the Commodity Credit Corporation to provide loans at 90 percent of parity for two years after the official end of hostilities for a broad range of crops and farm animals, including cotton, corn, wheat, rice, tobacco, peanuts, hogs, chickens, eggs, milk, butterfat, and potatoes. This provision did not raise major difficulties because the exceptional need



Peanut-grading machine in a Texas peanut-shelling plant during the 1930's. (Library of Congress)

for foodstuffs abroad absorbed nearly all available production during 1946 and 1947. The Agricultural Act of 1948 continued the loan program of the Commodity Credit Corporation at 90 percent of parity until June 30, 1950, when a flexible system was supposed to support prices at a level ranging between 60 and 90 percent of parity, depending on production totals. The move to avoid the rigidities of the parity formula, however, was undone by the surprise victory of Democratic Party presidential nominee Harry S. Truman during the 1948 election, a victory that owed much to farmer discontent over falling prices.

The Agricultural Act of 1949 was largely a victory for those who favored high price supports. Commodity Credit Corporation loans remained the major instrument for implementing the price-support program, and its loan rate became farmers' minimum-price guarantee.

High price supports, coupled with rapid growth in agricultural productivity because of the continuing revolution in technology, brought larger and more burdensome surpluses that were only temporarily alleviated by the Korean War (1950-1953). The Agricultural Act of 1954 represented a victory for more flexible and market-oriented price supports, but it did not change the system's basic structure. As output continued to grow, so did the stock of farm commodities in government hands. Farmers' resistance blocked a bid by the administrations of John F. Kennedy and Lyndon B. Johnson to impose mandatory production controls. By the 1960's, however, even farm bloc lobbyists recognized that high price supports were having a damaging influence on U.S. farm exports. The Food and Agriculture Act of 1965 introduced a new gimmick that became a standard part of the farm program: the "two-price" plan. To make American products competitive in the international market, domestic price supports were reduced to the world-market level through Commodity Credit Corporation loans. Producers were then paid a deficiency payment that amounted to the difference between the loan rate and the official target (or ought-to-be) price.

SIGNIFICANCE

Most agricultural economists agreed that the system used by the Commodity Credit Corporation had major flaws. It saddled the fed-

eral government with a multibillion-dollar commitment whose costs were unpredictable and encouraged chronic overproduction. Because of the alarmingly high levels to which Commodity Credit Corporation inventories and loans had risen by 1983, Ronald Reagan's presidential administration introduced the payment-in-kind (or PIK) program, whereby farmers were paid to take land out of production in return for a payment of government-owned stocks rather than cash. The 1983 PIK program temporarily relieved the carryover problem, but falling export demand in the years that followed produced a major crisis, and farm subsidy costs skyrocketed to an estimated \$26 billion in 1986 alone. Because farming interests remained sources of political power, the demand for subsidies remained high, and Congress usually responded to pressures from the farming industry. Subsidies distorted the marketplace, and this put pressure on the federal budget. These problems persisted into the early twenty-first century, as Congress made historic increases in farm subsidy levels that largely benefited the wealthiest farmers and agribusinesses.

John Braeman

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■ 1934-1939

DUST BOWL RAVAGES GREAT PLAINS FARMS

A massive drought ruined farms on a large scale throughout the plains states. Coming during the midst of the Great Depression, the so-called Dust Bowl exacerbated an already desperate situation, driving hundreds of thousands of farming families out of the Great Plains and prompting them to migrate westward to California.

LOCALE: American Great Plains

AGRICULTURAL ISSUES: Drought; Ecology and environment; Migration

KEY FIGURES

Robert Geiger (fl. early twentieth century), reporter who coined the term “Dust Bowl”

Franklin D. Roosevelt (1882-1945), president of the United States, 1933-1945

Hugh Hammond Bennett (1881-1960), chief of the Soil Conservation Service

Ferdinand A. Silcox (1882-1939), chief forester of the United States

Chester C. Davis (1887-1975), director of the Agricultural Adjustment Administration

Dorothea Lange (1895-1965), American photographer

SUMMARY OF EVENT

Farmers all across the Great Plains apprehensively watched the skies during the spring of 1934. Day after day, the weather offered no relief. Instead, there was intense sun, wind, drought, more sun, and then gales. Massive clouds of dust blotted out sunlight over western Kansas. At first, the wind raced along the surface, tearing at the stunted wheat and kicking up the topsoil. Then the dust thickened into low, heavy, dirt-laden clouds. From a distance, the storm had the appearance of a cumulus cloud, but it was black, not white; and it seemed to eat its way along with a rolling, churning motion.

THE DUST BOWL



As the storm swept toward Oklahoma and Texas, the black clouds engulfed the landscape. Birds and jackrabbits fled before it, and people scurried to safety. For those engulfed in the storm, there was an eerie sensation of silence and darkness. There was little or no visibility, and wind velocity hit forty to fifty miles per hour. That spring was exceedingly hot, with the temperature often above 100 degrees Fahrenheit. On May 10, the wind returned. Unlike the previous storm, these winds whipped up a formless, light brown fog that spread over an area nine hundred miles long. During the next day, an estimated twelve million tons of soil fell on Chicago, and dust darkened the skies over Cleveland. On May 12, dust hung like a pall over the entire eastern seaboard. These two storms alone blew 650 million tons of topsoil off the plains.

The Dust Bowl was an elusive and constantly moving phenomenon. The entire decade of the 1930's was unusually hot and dry. In 1930, there was a drought in the eastern half of the nation. In 1931, the drought shifted to the northern plains of Montana and the Dakotas, and local level dust storms throughout the plains became more

common. The storm that first brought the Dust Bowl to national attention, however, and gave it its name, was the one in May, 1934, which originated mostly on the northern plains and drew the dust high into the atmosphere, allowing the jet stream to deposit it over much of the eastern United States and even into the Atlantic Ocean. After that, the worst storms shifted to the southern plains and were typically more localized in extent. By many statistical measures, 1937 was the peak year for dust storm occurrence and severity, but in popular memory, the worst of the Dust Bowl over the largest area was probably during the early spring of 1934, including the famous "Black Sunday" storm of April 14.

The heart of the Dust Bowl is usually considered to be an area of 300,000 square miles in western Kansas, Oklahoma, and Texas and eastern Colorado and New Mexico, although conditions in the northern plains were, at times, equally deserving of the name Dust Bowl. In the hardest hit areas, agriculture virtually ceased. With successive storms, the wind and the flying dust cut off the wheat stalks at ground level and tore out the roots. Blowing dirt shifted from one field to another, burying crops not yet carried away from the wind. Cattle tried to eat the dust-laden grass and filled their stomachs with fatal mud balls.

The dust banked against houses and farm buildings like snow, burying fences up to the post tops. Dirt penetrated into automobile engines and clogged the vital parts. Housewives fought vainly to keep it out of their homes, but it seeped in through cracks and crevices, through wet blankets hung over windows, through oiled cloth and tape, covering everything with grit. Hospitals reported hundreds of patients suffering from "dust pneumonia." The black blizzards struck so suddenly that people became lost and disoriented and occasionally suffocated, some literally within yards of shelter. As a result, more than 350,000 people fled the Great Plains during the 1930's. These "Okies" loaded their meager household goods on flivvers and struck out along Route 66 for California.

Wind and drought alone did not create the Dust Bowl. Nature's delicate balance of wind, rain, and grass had been disturbed by human settlement. Fifty years earlier, a strong protective carpet of grass had covered the Great Plains. The grass held moisture in the soil and kept the soil from blowing away. In dry years, the wind blew out huge

THE DUST BOWL EXPLAINED

In 2004, scientists at the National Aeronautics and Space Administration determined the causes of the Dust Bowl disaster.

NASA scientists have an explanation for one of the worst climatic events in the history of the United States, the “Dust Bowl” drought, which devastated the Great Plains and all but dried up an already depressed American economy in the 1930’s.

Siegfried Schubert of NASA’s Goddard Space Flight Center, Greenbelt, Md., and colleagues used a computer model developed with modern-era satellite data to look at the climate over the past 100 years. The study found cooler than normal tropical Pacific Ocean surface temperatures combined with warmer tropical Atlantic Ocean temperatures to create conditions in the atmosphere that turned America’s breadbasket into a dust bowl from 1931 to 1939. The team’s data is in this week’s [March 19, 2004] *Science* magazine.

These changes in sea surface temperatures created shifts in the large-scale weather patterns and low level winds that reduced the normal supply of moisture from the Gulf of Mexico and inhibited rainfall throughout the Great Plains.

“The 1930s drought was the major climatic event in the nation’s history,” Schubert said. “Just beginning to understand what occurred is really critical to understanding future droughts and the links to global climate change issues we’re experiencing today.” . . .

The researchers used NASA’s Seasonal-to-Interannual Prediction Project (NSIPP) atmospheric general circulation model and agency computational facilities to conduct the research. The NSIPP model was developed using NASA satellite observations, including: Clouds and the Earth’s Radiant Energy System radiation measurements; and the Global Precipitation Climatology Project precipitation data.

The model showed cooler than normal tropical Pacific Ocean temperatures and warmer than normal tropical Atlantic Ocean temperatures contributed to a weakened low-level jet stream and changed its course. The jet stream, a ribbon of fast moving air near the Earth’s surface, normally flows westward over the Gulf of Mexico and then turns northward pulling up moisture and dumping rain onto the Great Plains. As the low level jet stream weakened, it traveled farther south than normal. The Great Plains dried up and dust storms formed.

Source: “NASA Explains ‘Dust Bowl’ Drought.” National Aeronautics and Space Administration, March 18, 2004.

craters, later mistakenly called “buffalo wallows”; but as long as the turf remained, the land could recover. After the U.S. Civil War (1861-1865), farmers began staking out homesteads in regions once considered too arid for use as anything but rangeland. Wherever they went, they plowed under the grass.

During World War I, the demand for wheat, along with the invention of the tractor, led them to plow larger areas of the virgin grassland. Between 1914 and 1917 the area of wheat planted increased to 27 million acres; more than 40 percent of this land was being plowed for the first time. After the war, the plowing continued. Larger tractors and combines, new machines that could harvest and thresh grain in one operation, inaugurated the age of the wheat kings. By 1930, there were almost three times as many acres in wheat production as ten years earlier, and the tractors were still tearing open the turf. The plow exposed the land to rain, wind, and sun. By 1932, the earth on the plains was ready to blow.

SIGNIFICANCE

The Dust Bowl speeded the development of long-range federal programs in the new field of soil conservation. A veteran conservationist,



Severe example of the impact of Dust Bowl conditions on midwestern farms. (National Archives)

President Franklin D. Roosevelt in late 1933 created the Soil Erosion Service, later the Soil Conservation Service (SCS), with Hugh Hammond Bennett as its head. The SCS's task was to supply technical assistance and leadership, while local soil-conservation districts carried out Bennett's program of strip cropping, contour plowing, stubble-mulch farming, and terracing. In 1934, the Forest Service, under Ferdinand A. Silcox, started planting a shelter belt of trees within a zone one hundred miles wide from Canada to the Texas Panhandle. Ten years later, more than 200 million trees were serving as wind-breaks and helping to conserve moisture. In 1936, the Agricultural Adjustment Administration (AAA), directed by Chester C. Davis, adopted soil conservation as a subterfuge to get around an unfavorable Supreme Court decision. On the Great Plains, however, soil conservation was a legitimate part of the AAA program. Farmers received government checks for both acreage reductions and wind control practices.

After 1936, the New Deal added little to its conservation program. Roosevelt did appoint two special committees, one to study Dust Bowl conditions and the other to recommend specific legislation. Congress passed a water-storage bill along the lines that the latter committee had suggested, but it did little else. In documenting the extent of the Dust Bowl and providing information and arguments to support their own programs, however, federal agencies created a wealth of documentary information on the Dust Bowl, including human responses to it, as recorded in the photographs of Dorothea Lange.

There has continued to be a lively debate over who or what—government programs, conservation practices of individual farmers, or Mother Nature—should receive most of the credit for bringing the Dust Bowl to an end, with the majority of scholars placing the greatest responsibility with nature. In any case, by 1938, the scale of wind erosion had dropped dramatically, and by 1941, temperature and rainfall levels had returned to near or above normal and the Dust Bowl had effectively disappeared. More to the point is the question of its possible recurrence. During the 1970's, Great Plains farmers were once again plowing "fence row to fence row" for export, grasslands were plowed up for irrigation farming, and the shelter belt had mostly been destroyed or allowed to deteriorate. Whether the

government and the people of the plains learned the appropriate lessons from the terrible experience of the Dust Bowl remains an open question.

Donald Holley and Kent Blaser

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■ JUNE 28, 1934

TAYLOR GRAZING ACT EXTENDS FEDERAL CONTROL OVER RANGELANDS

The Taylor Grazing Act brought belated federal control of grazing to the public domain rangelands of the West and marked the end of the homestead movement and the closing of the public domain.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Agrarian reform; Animal husbandry; Cattle keeping; Drought; Government policy and regulation; Land and land policy

KEY FIGURES

Edward T. Taylor (1858-1941), U.S. congressman from western Colorado

Farrington Carpenter (1886-1980), attorney and northwestern Colorado rancher

Harold Ickes (1874-1952), U.S. secretary of the interior, 1933-1946

Franklin D. Roosevelt (1882-1945), president of the United States, 1933-1945

Theodore Roosevelt (1858-1919), president of the United States, 1901-1909

SUMMARY OF EVENT

Until the forest reserves were established during the 1890's, the U.S. Congress envisioned an American West of cultivated, 160-acre homesteads. However, the Homestead Act (1862) failed to recognize the arid nature of much of the country's unoccupied land. In response, the livestock industry saw opportunity and profit in the uncultivated rangelands that had been vacated by the relocation of Native Americans and the demise of the bison. Increases in U.S. population and development of the country's railroads made commercial livestock production lucrative, and foreign capital sought profit in the new trade. The U.S. Department of Agriculture estimated that the cattle population increased from about eight million to more than twenty-

one million from 1870 through 1886 in the seventeen western states. The boom was followed by a bust of dramatic proportions. Many cattle, weakened by a lack of forage from overgrazing, died in the severe winters of 1885-1886 and 1886-1887. Livestock mortality was estimated at 40 to 60 percent, and some areas reported death rates of 85 percent.

As homesteaders pushed West, conflicts with ranchers followed. There was no provision for acquiring grazing land under the public-land laws, and in many cases, ranchers used fraud to gain title to large areas of public land. This fraud, coupled with their foreign financing, made them easy political targets, and they were considered land barons and monopolists.

During the 1880's, Congress ignored the recommendations made by the first Public Lands Commission to sell grazing lands in 2,560-acre parcels. Ranchers illegally fenced public lands and limited access to water resources to protect their range rights. In 1885, Congress declared public domain fencing illegal, but the practice prevailed. In 1901, the federal government prosecuted 161 cases of illegal fencing and estimated that about 2.5 million acres had been illegally enclosed. These rancher-homesteader conflicts were often apparent in state and local politics. Community boosters encouraged farming and settlement. States and railroads encouraged immigration for farming and opposed early bills that would have allowed ranchers to fence or lease public domain rangeland. Many ranchers feared any government regulation. The results were political stalemate and continued damage to the rangeland ecosystem.

By 1890, the effects of overgrazing were becoming obvious. Western soil and water resources were severely depleted, and a group of cattle and sheep ranchers began to form a consensus about the lease of public rangelands. The states of Texas and Wyoming, the Northern Pacific Railroad Company, and the federally managed Indian reservations reported success in reducing overgrazing through leasing as early as 1883. Rangeland leasing bills were introduced in Congress in 1901 and 1902, but they failed in the face of opposition from western governors and homestead interests.

Despite political risk, President Theodore Roosevelt began to support rangeland leasing proposals after the 1904 election. However, many people believed that Roosevelt was siding with monopolistic,

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big business interest groups at the expense of farmers, and his support of the leasing proposal was particularly opposed by irrigation and reclamation interests. Still, a provision for leasing public rangelands under the Department of Agriculture was included in the 1907 Agriculture Appropriations Bill and was at least partially responsible for the first major defeat of Roosevelt's conservation program. The defeat precluded serious consideration of additional leasing bills until the 1920's.

From 1909 through 1915, Congress passed a series of enlarged homestead acts that established 320-acre homesteads. Millions of acres of rangeland were plowed and sown to grain, which had disastrous consequences for the soil. Declining prices and severe drought ended the boom after World War I. In 1916, in spite of the opposition of ranchers, Congress passed a law to allow individuals to obtain 640 acres of public land that was valuable chiefly for grazing and cultivating forage crops. In the law's first year, about sixty thousand applications were filed for some twenty million acres under the Stock-Raising Homestead Act (1916). Unfortunately, it was only through firsthand experience that many applicants learned that the twenty to thirty cattle that could be supported on 640 acres of good rangeland were too few to support a family.

With the support of the livestock industry, the U.S. Forest Service had made significant progress in controlling livestock grazing in the national forests. By establishing allotments, carrying capacities, and grazing fees, the Forest Service had brought a semblance of order to a disorderly field. In 1919, ranchers in northeastern California petitioned the government to move 400,000 acres of public domain rangeland into the Modoc National Forest.

During the early 1920's, many ranchers supported proposals to have the Department of Agriculture administer a leasing program, but a proposal to increase grazing fees on the national forests rapidly ended their support. In 1925, a Senate committee introduced a bill that called for reform of Forest Service's rules about grazing and leasing of the public domain. The administration and the ranchers eventually reached a compromise, and it appeared that a leasing bill would pass, but the ranchers' rhetoric inflamed the conservationists. The American Forestry Association and the Society of American Foresters rallied opposition to the bill, and it failed. In 1928, Congress

Taylor Grazing Act Extends Federal Control Over Rangelands

authorized an experimental cooperative grazing program in southeastern Montana. The Mizpah-Pumpkin Creek Grazing District combined lands from the public domain, the Northern Pacific Railroad, the state of Montana, and private lands and leased them to a grazing association.

In 1931, members of Congress from Utah and Idaho introduced a general public domain leasing bill after consulting with the Departments of Agriculture and the Interior and gathering support from the White House. In 1933, Congressman Edward T. Taylor reintroduced a modified version of this bill and shepherded it through the opposition's objections, which were largely centered on contentions that the new bill unfairly favored large interest groups. Taylor also found a way to skirt the growing feud between the Departments of Agriculture and the Interior over which department would administer the public domain program. When the bill initially failed, Secretary of the Interior Harold Ickes threatened to withdraw the lands. President Franklin D. Roosevelt's active support of the Taylor bill also improved its chances for passage. The Taylor Grazing Act passed the House of Representatives on April 11, 1934, and a slightly different



Edward T. Taylor around 1910.
(Library of Congress)

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version passed the Senate on June 12, 1934. Roosevelt signed the conference committee version on June 28, 1934.

SIGNIFICANCE

The Taylor Grazing Act of 1934 marked the end of fifty years of political struggle over control of the unallocated public lands in the western United States. The act gave the secretary of the interior broad powers to control livestock grazing by establishing grazing districts and regulating the use of the public domain pending its final disposal by Congress. It also ended free access to the public range and began the process of controlling livestock grazing, firmly established local control over allocation of public rangelands, and effectively ended large-scale public-land disposals. The first grazing district was established in Wyoming in 1935, and others followed in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, and Utah. Ranchers recommended fifty districts covering 142 million acres. Since this area was larger than the one provided by the original act, in 1936 the act was amended to allow the larger area.

The effort to implement the Taylor Act was one of the most ambitious land-management actions undertaken by the federal government. Allocation of grazing privileges and fees, fencing, water development, erosion, and fire control were initiated, and in the act's first year, the Civilian Conservation Corps (CCC) operated sixty camps with twelve thousand men to aid the program. In many areas, recovery from decades of abusive grazing was a stubborn problem. By the mid-1960's, experts estimated that production in three-fourths of western ranges was at less than half of its potential.

In some areas, large reductions in livestock use were required to bring grazing into balance with carrying capacity. Organized local opposition to the reductions was often strong. To restore productivity, managers undertook forage improvement projects that often relied on clearing sagebrush and woodlands and reseeding with improved forage grasses. As the environmental movement gained strength during the 1960's and 1970's, range managers were often criticized for concentrating on livestock production at the expense of wildlife habitat. Protection and recovery of degraded riparian areas became a particular concern during the 1980's.

When the Taylor Act passed, Farrington Carpenter, a Colorado

rancher and lawyer, was selected to head its implementation. By the end of 1935, the Division of Grazing employed fewer than thirty people and administered 258 million acres of rangeland. Carpenter relied on local advisory committees authorized by the act. These committees allocated each district's forage based on a complex system of historical use and adjacent private land or water to establish "preference," which in many cases exceeded the available forage. In 1944, the Grazing Service was administering more than twenty-two thousand licenses and permits and approximately 3.8 million animal units of forage. (An animal unit is the amount of forage necessary to feed a 1,000-pound animal for twelve months.) In 1992, the Bureau of Land Management reported about 1.1 million animal units of preference and about 833,000 animal units of actual use.

By the end of the second year, the ranchers had elected 523 district advisers. The advisory boards' role was clearly defined in a 1939 amendment to the Taylor Act: Boards were to consist of at least five but no more than twelve members to be appointed by the secretary of the interior following election and recommendation of the boards. The secretary of the interior was also allowed to add one member to represent wildlife interests. District advisory committees later elected state and national advisory committees.

The 1930's were a period of intense rivalry between the Department of Agriculture and the Department of the Interior. In his bid for control of the program, Secretary Ickes had promised that the Interior Department could manage public lands for \$150,000 per year, and he also promised a grazing fee based on that low administrative cost. By giving the ranchers a largely autonomous program, Ickes thwarted the efforts of the Department of Agriculture and the Forest Service to gain control of the lands as the original bill was amended.

The Taylor program ensured continuing support from the Department of the Interior by relying on local advisory committees. In addition, however, more general forms of local assistance and cooperation were necessary. In some respects, this form of home rule seemed an ideal mechanism for undertaking a large-scale land-management program at a minimal cost. Advisory board members were commended as outstanding examples of citizen participation in government. In contrast, conservation groups often lacked organized, effective representation in the rural West. Amenity interests were not

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well protected by the ranchers, and after the growth of the environmental movement during the 1960's and 1970's, their absence in the decision-making process became a source of continuing conflict.

Although Taylor initiated the act that effectively ended public-land disposal, he was, like many rural westerners, opposed to a continual federal presence in the region. He generally supported decreasing the restrictions on homesteaders and was one of the authors of the 1916 Stock-Raising Homestead Act. Like many westerners, he viewed the Taylor Act as a temporary measure to stabilize the livestock industry. The clause that referred to the land's final disposition would cause considerable consternation and political upheaval before it was finally resolved by the Federal Land Policy and Management Act of 1976.

Donald W. Floyd

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SEE ALSO: 9th-15th centuries: North American Plains Village Culture Flourishes; 1874: Barbed Wire Fencing Transforms American Ranching; 1879: Powell Recommends Water Management Schemes for Western Agriculture; 1934-1939: Dust Bowl Ravages Great Plains Farms; April 27, 1935: Soil Conservation Service Combats Dust Bowl Conditions; July 16, 1946: Truman Creates the Bureau of Land Management.

■ APRIL 27, 1935

SOIL CONSERVATION SERVICE COMBATS DUST BOWL CONDITIONS

The Soil Conservation Service was established to alleviate problems created by the Dust Bowl of the 1930's, in which some of the nation's most productive topsoil blew away as a result of poor land management.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Drought; Fertilizers; Flooding; Government policy and regulation; Land and land policy; Scientific research

KEY FIGURES

Hugh Hammond Bennett (1881-1960), soil conservationist and the first director of the Soil Conservation Service

Milburn L. Wilson (1885-1969), assistant secretary of agriculture, 1934-1937

Franklin D. Roosevelt (1882-1945), president of the United States, 1933-1945

SUMMARY OF EVENT

The Great Depression and the drought of the early 1930's alerted U.S. leaders to the need for government to take a more active role in resource management. During President Theodore Roosevelt's administration, a number of initiatives were introduced, and in 1935 Congress passed the Soil Conservation and Domestic Allotment Act, which established the Soil Conservation Service (SCS). Although the findings from field research at experimental erosion stations, the worldwide economic depression, and dust storms resulting from drought conditions were all important considerations, the legislation was largely passed as a result of efforts by Hugh Hammond Bennett, the father of modern soil conservation in the United States, who used his knowledge to garner political support for national soil-conservation programs.

Concern for soil erosion was common in the United States, especially in the South. After observing contour plowing in France,



Severely eroded Alabama farm during the mid-1930's. (Library of Congress)

Thomas Jefferson and his brother-in-law, Thomas Mann Randolph, introduced the method in Virginia. By 1850, contour plowing was common in the South. The Southwest Soil and Water Conservation conference, held in Texas in 1929, helped to bring attention to the problem of soil erosion. Still, soil erosion did not warrant national concern until the Great Depression of the 1930's, when the connection between poor soils and poor people became apparent.

During the 1930's, millions of people were unemployed and desperate for work. The market system did not appear to be functioning, and the nation's economic woes were exacerbated by the drought. During the 1932 presidential election campaign, Franklin D. Roosevelt promised to do something about the stagnant economy and high unemployment rate by offering people a "New Deal," and after his inauguration in 1933, he initiated a large-scale government-spending program. One aspect of this initiative was the National Industrial Recovery Act (1933), a broad-based act that provided stimulus for all sectors of the economy. Although the Soil Conservation Service (SCS) was not established until 1935, its predecessor, the Soil Erosion

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Service, was established as a temporary agency of the U.S. Department of the Interior under the 1933 act. When the Civilian Conservation Corps (CCC) was established in 1933, several hundred CCC camps were assigned to the Soil Erosion Service, giving impetus to erosion-control efforts.

A soil scientist for the U.S. Department of Agriculture, Bennett was employed to direct the Soil Erosion Service. He had firsthand experience with soil erosion in North Carolina; moreover, he had seen the effects of erosion while working as a surveyor and as a supervisor of surveys in the South. In 1928, he and W. R. Chapline published a paper titled "Soil Erosion: A National Menace." This U.S. Department of Agriculture publication, along with other articles that appeared in such widely read publications as *Nature*, *Geographical Review*, and *Farm Journal*, alerted politicians and the public to the severity of the nation's erosion problem.

When Bennett took control of the Soil Erosion Service in 1933, his budget was \$5 million. Soil-conservation projects were strategically located in watersheds near erosion-control experiment stations so that the research findings could be readily employed, and farmers signed five-year cooperative agreements to employ the recommended conservation measures. In return, the Soil Erosion Service provided them with equipment, seeds, seedlings, lime, fertilizer, soil-conservation assistance, and labor from the CCC or the Works Progress Administration (WPA).

Many of the conservation practices promoted by the Soil Erosion Service were not new. Various methods in a conservation system, however, were designed specifically for each individual farm. For example, strip cropping under longer rotation was encouraged for hay and small grain crops. Administrators also emphasized pasture management by using fertilizers and fencing off woodland from grazing in hilly areas to reduce runoff, and many farmers were introduced to grassed outlets, grassed waterways, and grade stabilization techniques.

SIGNIFICANCE

The Soil Erosion Service was shifted from the Department of the Interior to the Department of Agriculture and was given permanent status under the Soil Conservation Act. Its name was changed to the

Soil Conservation Service (SCS), and its responsibilities centered on planning and conducting a national program to conserve and develop the nation's soil and water resources. If not for the activities of the Soil Conservation Service, the physical landscape of the United States would be much less stable.

CCC workers conducted a number of demonstration projects. Seeds for nursery production of seedlings were collected for reforestation, native grasses were used to revegetate rangeland in semiarid regions, water filtration was enhanced by water-spreading systems and contour furrows, and livestock grazing was redistributed with the use of stock-watering in ponds and springs. Demonstration projects aimed at improving rangeland through range management were also implemented on Native American reservations. The demonstration projects' results were so convincing, in fact, that farmers who visited areas where these projects were being implemented also began to ask for assistance.

Realizing that the CCC and WPA workers would be available only



Iowa farm of the late 1930's using a crop rotation system in which one field is used for corn (upper right), another is for alfalfa (foreground), and the third is left fallow (upper left). (Library of Congress)

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temporarily, the assistant secretary of agriculture, Milburn L. Wilson, devised a plan for making a sustained supply of conservation expertise available to farmers. His plan called for the development of soil-conservation districts, which provided for greater local participation in the planning operations. The Standard State Conservation Districts Law was sent to state governors on February 27, 1937, by President Roosevelt. After each state passed the law, districts were organized around local watersheds or county boundaries, and supervisors were elected. Districts signed agreements with the Department of Agriculture, which provided nearly three thousand districts with trained soil conservationists, who worked directly with farmers. Through these planning districts, the SCS developed a land-classification system and associated soil management practices that did much to restore the fertility of American soils after periods of degradation.

Over the years, the responsibilities of the Soil Conservation Service grew to include a variety of tasks, and the SCS tried to promote soil conservation in a number of ways. Soil conservation was enhanced by employing conservation methods based on scientific research findings, by developing an agency of technically trained personnel to carry out soil conservation in farm communities, and by creating soil-conservation districts. Furthermore, the agency shared in the cost of establishing and implementing soil-conservation practices.

The Soil Conservation Service came to be widely recognized for its soil surveys and maps. The surveys examined the soil's physical attributes, revealing such information as soil moisture, texture, slope, erosion, and chemistry. This information was supplemented by laboratory studies and was used for selecting sites for specific land uses. Each soil survey described the key characteristics of soils in a survey area, classified and named the soil according to a nationwide system, provided information on the potential and limitations of soils for various uses, and showed the soil distribution on a detailed map. More than one billion acres of land were mapped, and maps of millions of additional acres were added each year. The soil surveys and maps were published, and the SCS also cooperated with other agencies that prepared special reports and maps relevant to soil surveys.

More than one hundred new plants were identified by the Soil Conservation Service's Plant Materials Center. This group searched

for plants that lend themselves to stabilizing waste disposal areas, extending grazing seasons, improving windbreaks and shelterbelts, and reducing air pollution, snow drift damage, and wind erosion. More than twenty-three thousand plants were examined after 1938, and more than one hundred were released for conservation purposes.

The Soil Conservation Service also became involved in a comprehensive system of land-resource conservation, and it analyzed alternate soil-conservation methods and management practices required to safeguard the soil under different cropping systems. The practices included such methods as no-till and minimum-tillage farming, contour plowing, terracing, strip cropping, stubble mulching, and the efficient use of fertilizers. On rangeland, the SCS pioneered the use of range inventory methods that incorporated ecological principles and concepts as well as practical methods for range management. Furthermore, thousands of pilot studies correlated soils with tree growth, and these analyses were made available to woodland conservationists.

Hundreds of millions of acres of land were restored or stabilized as a result of these practices, and farmers and other land users were given the latest information pertaining to crops and their use and management. Land users received assistance with wildlife conservation efforts, recreational land-use projects, and campaigns to prevent land-disturbing activities. The Food and Agriculture Act of 1962 authorized the Department of Agriculture to assist landowners with developing recreational resources. Nearly two million lakes and ponds were built on farms and ranches by the SCS, which also helped soil-conservation districts to help stabilize mine spoils and reclaim hundreds of millions of acres of land.

Watershed projects enacted in 1954 under the Watershed Protection and Flood Prevention Act established soil- and water-conservation measures on private and public land and allowed for the construction of dams and other water-control structures on upstream tributaries to ensure effective water management. This activity was administered by the Soil Conservation Service, which also administered work on watersheds that was authorized by the Flood Control Act of 1944 in eleven major watersheds covering about thirty million acres. These watershed projects helped control flooding and erosion while supplying water for irrigation, industrial, and municipal uses.

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The Soil Conservation Service also became involved with some of the provisions of the Food Security Act of 1985. Under this program, SCS conservationists worked directly with farmers to determine soil erodibility as it applied to the preservation of wetlands. Some of the most erodible land was taken out of production and covered with protective vegetation, and farmers received rental payments in return. Although the effectiveness of soil-conservation efforts has been debated by some, the nation's soils are much more protected as a result of the Soil Conservation Service's work. In 1994, the Soil Conservation Service was subsumed under the National Resources Conservation Service, part of the Department of Agriculture.

Jasper L. Harris

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■ MARCH 11, 1936

COMPLETION OF BOULDER DAM IMPROVES SOUTHWESTERN IRRIGATION

Completion of Boulder Dam provided irrigation, municipal water, flood control, and abundant power, but it also catalyzed great environmental and economic change.

ALSO KNOWN AS: Hoover Dam

LOCALE: California; Nevada; Arizona

AGRICULTURAL ISSUES: Drought; Ecology and environment; Flooding; Irrigation and water management

KEY FIGURES

Henry J. Kaiser (1882-1967), American industrialist and leading figure in the Six Companies consortium

Elwood Mead (1858-1936), American commissioner of reclamation

Ray Lyman Wilbur (1875-1949), president of Stanford University and U.S. secretary of the interior

Herbert Hoover (1874-1964), U.S. secretary of commerce and federal representative to the Colorado River Commission

Philip D. Swing (1884-1963), U.S. congressman from California

Oliver M. Wozencraft (1814-1887), physician, promoter, and member of the California Constitutional Convention and the first state legislature

Frank Crowe (1882-1946), civil engineer who was superintendent of construction for Boulder Dam

Arthur Powell Davis (1861-1933), hydrographer and engineer who directed the Reclamation Service in initial stages of development of Boulder Dam

Walker Young (1884-1982), engineer who represented the Bureau of Reclamation on the scene as construction engineer and led preliminary tests of sites in Boulder and Black Canyons

SUMMARY OF EVENT

Boulder Dam (also called Hoover Dam after 1947) was officially accepted by Secretary of the Interior Harold Ickes on March 11, 1936.



Boulder Dam, looking northeast, above the effluent of Lake Mead. (Nevada Commission on Tourism)

On completion, the dam was the world's highest and largest, rising 727 feet above bedrock and containing more than three million cubic yards of concrete. The Grand Coulee Dam, completed in 1942, surpassed it with more than ten million cubic yards of concrete, and the Mauvoisin Dam, completed in Switzerland in 1958, was the first higher dam at a height of 777 feet. Lake Mead was formed by Boulder Dam; with a capacity of more than 31 million acre-feet of water, it was the world's largest reservoir until 1959, when the Kariba Dam on the Zambia-Zimbabwe boundary created a reservoir of 130 million acre-feet capacity. Boulder Dam and Lake Mead, however, remain among the largest structures of their kind.

The Boulder Dam project had its roots in Oliver M. Wozencraft's efforts to promote diversion of Colorado River water to irrigate the Imperial Valley of California. In 1859, at Wozencraft's instigation, the California legislature passed a bill petitioning Congress to cede the Imperial Valley to the state for reclamation purposes. Wozencraft's desert-land bill finally was introduced in Congress in 1862 but failed to pass. Private construction of irrigation works began in 1898, and the first water was diverted in 1901. Severe floods in 1905 and 1906 broke through the levees and canals, bringing Colorado River water

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to the Salton Depression and creating the Salton Sea. It took two years to bring the flood under control, and the strong possibility remained that the river could break through again. A flood would inundate more than one million acres of irrigated farms. Erosion of the channel also threatened to dry out additional irrigated lands at Yuma, Arizona, and farmland to the north. Furthermore, the 1905-1906 flood and subsequent floods exceeded the financial capacity of private companies and irrigation districts to maintain irrigation systems in the valley. The inability of private organizations to cope with the flood threat and the advent of proposed private hydroelectric power schemes resulted in appeals for governmental intervention.

Conflicting claims by the states of the Colorado basin for river water and the perceived need to regulate public and private power caused Congress, on August 19, 1921, to authorize the states of the Colorado River drainage basin to enter into a compact dividing the basin's waters. The Colorado River Commission, which was composed of representatives of the states as well as the secretary of commerce, was appointed by the president and states. At the commission's first meeting, on January 26, 1922, Herbert Hoover, the U.S. secretary of commerce, was elected chairman. After prolonged controversy, the Colorado River Compact was signed by the commission on November 24, 1922, opening the way for unified development of the Colorado River basin. The means by which that development was achieved, however, remained controversial.

The Colorado River Compact divided the basin into a lower basin comprising Arizona, California, and Nevada and an upper basin within Utah, New Mexico, Colorado, and Wyoming. Both basins were allocated 7.5 million acre-feet of water and the right to draw an additional 1 million acre-feet of unallocated water for beneficial consumption if additional water was available. Division of water within the upper and lower basins, however, was not specified, and conflict between Arizona and California remained an obstacle. The water allocated was designated primarily for domestic and agricultural purposes, secondarily for power generation, and thirdly for navigation. Much later, Mexico was allocated 1.5 million acre-feet from the surplus waters. If there was insufficient surplus water to supply the Mexicans, the lower and upper basins were required to surrender equal amounts to fulfill the Mexican quota. Arizona and the upper-basin



states immediately objected, because California had already appropriated all, or nearly all, of its share of the water and was prepared to take more. In contrast, the upper-basin states lacked the dams and reservoirs needed for storage and diversion of their share of the water. In addition, conflicts over the role of government and private enterprise in producing and selling electrical power delayed construction.

After prolonged political maneuvering, the fourth Swing-Johnson bill (named for its primary author, Congressman Philip D. Swing of

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California), which authorized the Boulder Canyon Project, passed Congress on December 19, 1928. Three previous versions failed to pass in 1922, 1923, and 1925. Under the terms of the act, also known as the Boulder Canyon Project Act, a high dam and reservoir were to be constructed at either Boulder or Black Canyon in order to control floods, improve navigation, regulate the flow of the Colorado River, store water for reclamation and other beneficial purposes exclusively within the United States, and generate electrical energy. Construction of the Imperial Dam and All-American Canal, which were designed to divert water to the Imperial Valley by means of works entirely within the United States, also was authorized in the bill.

Construction of the high dam commenced on May 16, 1931. Because of engineering considerations, the dam was built in Black Canyon instead of in Boulder Canyon. A town, a railroad, a highway, and power lines were built to allow construction to proceed in the previously isolated, uninhabited area. Four diversion tunnels were driven around the site, and a cofferdam was erected to keep the river out of the dam site. The diversion tunnels became operable in March, 1931, and the upper cofferdam was completed in March, 1933. On June 6, 1933, the first concrete was poured for the dam after the rock abutments had been stripped and the valley floor excavated to bedrock. On March 23, the main body of the dam was completed to crest elevation. The large volume of concrete required cooling to dissipate the heat of curing and to avoid cracking and deforming the dam. For this purpose, refrigerant piping was buried in the concrete, and a substantial refrigeration plant was built to supply internal cold-water circulation. This technique, invented for Boulder Dam's construction, was later used for building other massive concrete structures.

The dam began regulating Colorado River flow on February 1, 1935. It was dedicated on September 30, 1935, and was accepted by Secretary of the Interior Harold Ickes on March 1, 1936, two years and two months ahead of schedule, at a cost of \$51,950,000—essentially the price at which it had been bid. By June, 1937, the power plant was in routine operation, although not all the contemplated turbines and generators were installed until decades later. The dam was renamed Hoover Dam in 1947 to honor Herbert Hoover, who as secretary of commerce and as president of the United States played a large role in the dam's construction.

SIGNIFICANCE

Boulder Dam fulfilled all the purposes for which it was built. Irrigation water was supplied to the Imperial Valley and riverine lands below the dam. Water stored in the reservoir became available to maintain irrigation during droughts. Flooding on the Lower Colorado River occurred only once after completion of the dam, and the great flood of 1953 would have been far more severe without storage of much of the waters in Lake Mead. An installed capacity of 4.33 million kilowatt-hours of electric power was expected upon installation of all planned generators. Additional benefits of the dam's construction included temporary stimulation of the economy during the midst of the Great Depression and creation of a major recreational resource. This resource, the Lake Mead National Recreation Area, preserved a large area of desert environment.

Boulder Dam was the first very large modern dam, and it initiated worldwide expansion of large-scale hydroelectric and irrigation-dam construction. The Tennessee Valley Authority, the Columbia River basin system, and the Pick-Sloan program in the Missouri River basin were developed in part because of the momentum generated by completion of Boulder Dam. The federal government constructed more than one thousand dams between 1930 and 1980. Construction of the Parker Dam and the Colorado River Aqueduct began immediately after completion of Boulder Dam. Aqueducts to service San Diego and the Coachella Valley were built somewhat later and met California's primary objectives for the Boulder Canyon Project. Efforts to secure use of the upper basin and Arizona's share of the water, however, were unsuccessful.

The Colorado River Storage Project, which was approved by Congress in 1956, authorized construction of ten dams in the upper Colorado River basin. These dams were to store 48.5 million acre-feet of water and to ensure delivery of the upper basin's share of water as stated in the Colorado River Compact. Glen Canyon Dam, completed in 1966, was the largest of those actually built. The Central Arizona Project, authorized in the Colorado River Basin Project Act, signed on September 30, 1968, finally delivered Arizona's share of water allocated under the Colorado River Compact. The Colorado River Basin Act also provided for a domestic water aqueduct to Las Vegas, authorized several upper-basin dams and pro-

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Elwood Mead, the U.S. commissioner of reclamation from 1924 until his death in 1936, after whom Boulder Dam's Lake Mead is named. (Library of Congress)

jects, and assumed responsibility for delivering acceptable water to Mexico.

Although the completed works in the Colorado basin are adequate to deliver the water allocated to the states of the basin and Mexico, most people believe that the river does not supply enough water to meet the quotas. The estimated average annual flow, on which the allocations were based, was determined by available flow rate measurements. These measurements, however, were made during a wetter-than-average climatic cycle. As a consequence, virtually no water reaches the Gulf of California. In addition, irrigation water leaches salts from the soil and returns saline water to the river. This process, as well as the natural increase in salinity as the river crosses the Colorado Plateau and the desert, so degraded the river water at the Mexican boundary that it became unfit for irrigation. Crop damage in Mexico provoked protests from the Mexican government, and these protests culminated in 1973 with a threat to bring the matter before the World Court. This protest has been somewhat quelled by the au-

thorized construction of a \$300 million desalination plant to treat water crossing the border and additional salinity-control projects upstream. Water flowing downstream to the Gulf of California is even more highly saline and has greatly altered wetlands on the Colorado River Delta. Reduction in flow also has led to saltwater incursion on the delta.

Boulder Dam and Lake Mead remove all sediment from the Colorado River. As a consequence, the clear water below the dam erodes the bed and banks of the river. Also, the delta and the floodplain no longer receive sediment.

Water delivered by the Los Angeles and San Diego aqueducts permitted and stimulated the large population increase in Southern California. Irrigation water was ensured for the Imperial Valley and the districts along the Colorado River. Power from Hoover Dam serviced the pumps on the aqueducts and met a large part of the increased power demands during World War II. A magnesium reduction works at Henderson, Nevada, was the principal source of magnesium for the war effort. Inexpensive power also was sent to the zinc mines at Pioche, Nevada.

The dam's name has been subject to partisan political conflict and has been a source of confusion. The Democratic Swing-Johnson bills authorizing the dam referred to the Boulder Canyon Project and referred to the dam as Boulder Dam. On "driving the silver spike" on the branch line to the site, Ray Lyman Wilbur, Herbert Hoover's Republican secretary of the interior, named the dam Hoover Dam, and this name subsequently was used in congressional bills and appropriations. In May, 1933, the new Democratic secretary of commerce, Harold Ickes, changed the name to Boulder Dam. In 1947, the first Congress elected with a Republican majority since 1932 passed a bill restoring the name Hoover Dam. Democratic President Harry S. Truman signed the bill. This ended the partisan series of name changes, but both names remain in common use.

Ralph L. Langenheim, Jr.

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SEE ALSO: 1879: Powell Recommends Water Management Schemes for Western Agriculture; May 21, 1924: Farmers Dynamite the Los Angeles Aqueduct; June 28, 1934: Taylor Grazing Act Extends Federal Control Over Rangelands; April 27, 1935: Soil Conservation Service Combats Dust Bowl Conditions; January 15, 1971: Aswān High Dam Is Expected to Expand Egyptian Agriculture.

■ 1939

MÜLLER DISCOVERS INSECTICIDAL PROPERTIES OF DDT

Paul Hermann Müller's discovery that the chlorinated organic compound dichloro-diphenyl-trichloroethane (DDT) is an effective insecticide led to its widespread use for controlling vectors of disease and causes of devegetation.

LOCALE: Switzerland

AGRICULTURAL ISSUES: Chemistry; Disease and health issues; Pests and pesticides; Scientific research

KEY FIGURES

Paul Hermann Müller (1899-1965), Swiss chemist

Othmar Zeidler (d. 1911), German chemist

SUMMARY OF EVENT

It has been known for centuries that numerous species of insects are vectors of human diseases and causative agents of agricultural devegetation. The scientific community recognized this problem, and numerous researchers attempted to discover insecticides that were potent to insects yet relatively innocuous to humans, animals, and vegetation. Prior to the discovery of the insecticidal property of DDT in 1939 by Paul Hermann Müller, inorganic, arsenic-based insecticides were most commonly developed because of their effectiveness in controlling insects. These insecticides, which were initially used during the latter half of the nineteenth century, however, were found to be very toxic to humans and other mammals. Other common insecticides used prior to the 1940's were the inorganic fluorinated compounds plus organic-based nicotine, pyrethrum, and derris compounds. These substances, however, had limited application and insufficient permanent effect because of their instability in the environment.

Müller, a Swiss chemist, worked on developing an alternative to the most widely used inorganic arsenic-based insecticides while he was employed by the Swiss firm J. R. Geigy during the mid-1930's. He

thus did not concentrate on modifying the noncarbonaceous “inorganic” compounds consisting of the metal arsenic and other elements, which, when combined, produce arsenic salts, oxides, or hydrides depending on the elemental composition. Instead, he focused on carbon-containing “organic” compounds, which, when combined with the element chlorine, produce organochlorine compounds.

Müller’s task was to synthesize an original compound or to discover an existing one that would be not only an effective and safe insecticide but also economical and inoffensive in odor. Müller had determined from a review of the published scientific literature regarding patented insecticides that the most effective mode of inducing insecticidal activity was through direct contact of the compound with the insect. This meant that it was not necessary for the insects to consume the insecticides in order for a toxic effect (that is, death) to occur. He also concluded that for an insecticide to be effective, especially for agricultural use, it needed to be chemically stable and, accordingly, relatively resistant to decay or inactivation in the environment.

As a result of his conclusions drawn from the literature, Müller decided to study organochlorine compounds. Many compounds in this class were already known to be relatively chemically stable under ambient conditions. In addition, an organochlorine compound called chloroform was already known to exhibit insecticidal properties. Accordingly, Müller focused on studying organochlorine compounds that contained a chemical group similar to the chloroform molecule. He eventually discovered an organochlorine molecule that exhibited potent insecticidal activity.

In 1939, Müller and his research group at J. R. Geigy developed an insecticide product that they named Gesarol. Müller had discovered that the active ingredient in Gesarol was insecticidal when tested against beetles and moths. The active ingredient was the organochlorine DDT, which was originally synthesized in the laboratory of Othmar Zeidler, a German chemist, in 1874. Zeidler’s intention was not to develop an insecticide but to determine the substitution reactions involving chlorine atoms and aromatic organic compounds. Zeidler discovered the compound DDT as one of many products of such reactions, but its insecticidal property was unknown to anyone until years later.

Although Müller discovered the insecticidal properties of DDT in 1939 and the Swiss government put the compound to use almost immediately to control the devastating Colorado beetle, U.S. government approval of DDT for use as an insecticide was not sought until 1944. The American government, through several federal health agencies, conducted tests during 1942 and 1943 to determine the effectiveness of DDT. In addition, tests were conducted also to determine potential long-term (chronic) and immediate (acute) health effects to humans. Based on the results of the governmental tests, it was concluded that DDT was indeed effective for terminating insect pests, yet relatively innocuous to human health. The product Gesarol with its active ingredient, DDT, was suggested by the J. R. Geigy company for possible use to combat the insect vectors confronted by the American troops engaged in World War II and stationed in Europe, Africa, and the South Pacific, where they were exposed to typhus-carrying lice and mosquitoes that transmitted malaria. The idea was derived from historical documentation of the use of the insecticide pyrethrum during 1900 in Cuba and 1904 in Panama to destroy the species of mosquitoes that transmitted yellow fever (*Aedes*) and malaria (*Anopheles*) to humans. Although pyrethrum did not exhibit permanent activities, its use and the resulting benefits to soldiers in Cuba and workers in Panama demonstrated an effective application of an insecticide in order to decrease the outbreak of human diseases resulting from insect vectors. As a consequence of this historical account, the effectiveness of DDT, and the perceived innocuous impact to humans, the insecticide was selected by the U.S. government in 1944 as the optimal insecticide for use to protect American troops from the insect vectors that transmitted typhus and malaria. Later, the insecticide was released for agricultural and general commercial purposes following the war.

SIGNIFICANCE

The impact of using DDT as an insecticide can be viewed both positively and negatively. From a positive perspective, the insecticide proved to be instrumental in controlling insect pests and, in turn, preventing outbreaks of disease and destruction of vegetation. On the negative side, DDT was eventually shown to exhibit greater toxicity and potential for adverse environmental impact than originally reported.

It was documented that the use of DDT in Italy and Japan during World War II resulted in the cessation of outbreaks of typhus through the destruction of lice. The use of DDT in Naples during early 1944 to delouse clothing, the native inhabitants, and American and English troops marked the first reported time in which human beings were able to end a typhus epidemic at will. Equally as important, delousing programs using DDT helped to prevent future outbreaks of typhus in epidemic proportions.

Outbreaks of malaria, a disease transmitted by mosquitoes, which was endemic in the South Pacific islands during the war, were also decreased as a result of the use of DDT. The chemical insecticide was discharged from airplanes and sprayed liberally over the islands to control the proliferation of mosquitoes, without reported cases of toxicity to humans. As a result of the reported effectiveness of DDT in decreasing outbreaks of typhus and malaria among military personnel and its use to end and prevent typhus epidemics during the World War II era, Müller was awarded the 1948 Nobel Prize in Physiology or Medicine.

Following the U.S. government's approval of the use of DDT for agricultural and commercial purposes, the insecticide was used ex-



Biplane “dusting” crops with a pesticide during the late 1940’s. (The plane’s spray plume was enhanced in the original photograph to make it more visible.) (CDC/NIOSH)

tensively on American farms and in residential areas. Although it was effective and appreciated for protecting crops and combating insect infestations, concerns began to arise regarding the compound's toxicity. Evidently, the initial toxicity testing conducted by the U.S. government during the early 1940's and the lack of reported cases of illness among exposed troops during World War II were not accurate indicators of potential long-term or chronic health effects in humans.

Indiscriminate use of DDT during the postwar years resulted in reported contamination of food, water, and soil. In turn, the insecticide passed through the food chain, and DDT residues were detected in humans and other animals. It was discovered later that DDT has the propensity to absorb into and through biological tissue and accumulate in body fat. In addition, excessive exposure to DDT was determined to increase the risk of damaging the nervous system in humans and other mammals. These findings resulted in the eventual ban of DDT for use in the United States approximately thirty years following the discovery of its insecticidal property. It should be noted that although the insecticide is stable in the environment, tends to accumulate in fat tissue, and has the potential to induce adverse environmental impact, DDT did not cause any reported fatalities to humans. Indeed, in comparison with the alternatives available at the time, DDT was relatively safe. Unfortunately, the misuse and overuse of DDT led to excessive environmental contamination and, subsequently, to an end of its legal use.

Michael S. Bisesi

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SEE ALSO: 1917: American Farmers Increase Insecticide Use Mid-1940's: First Modern Herbicide Is Introduced November 20, 1969-December 31, 1972: DDT Ban Signals New Environmental Awareness October 21, 1972: U.S. Congress Expands Pesticide Regulations July 10, 1981: Brown Orders Medfly Spraying in California.

■ MAY 16, 1939

FIRST U.S. FOOD STAMP PROGRAM BEGINS

The first food stamp plan established by the U.S. Department of Agriculture began as an experiment in Rochester, New York.

LOCALE: Rochester, New York

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Government policy and regulation; Marketing and trade

KEY FIGURES

George D. Aiken (1892-1984), U.S. senator from Vermont

Christian Archibald Herter (1895-1966), U.S. congressman from Massachusetts

Robert M. La Follette, Jr. (1895-1953), U.S. senator from Wisconsin

Henry A. Wallace (1888-1965), U.S. secretary of agriculture, 1933-1940

SUMMARY OF EVENT

In May, 1939, eleven million people in the United States were receiving federal food assistance through direct donations of commodities. At that time, various groups were searching for methods of increasing consumption of grapefruit and other surplus foods. In January, 1939, at the National-American Wholesale Grocers Convention in Chicago, a plan developed by the grocers had been presented that proposed the issuance of "scrip" vouchers to unemployed people and those with low incomes. The vouchers would permit recipients to purchase designated foods and foodstuffs at retail grocery stores at prices 50 percent below normal. The federal government would make up to grocers the difference between the amount actually charged and the normal price. The plan's cost to the government was estimated at \$1.4 billion. In addition to providing food to the needy at reduced prices, the plan would help wipe out agricultural surpluses.

The plan was submitted to the National Food and Grocery Confer-

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ence Committee, which was composed of representatives from all areas of the food industry, from manufacturers to retailers. The U.S. Department of Agriculture explored the proposal, and at a meeting of the committee on March 13, 1939, department representatives announced an experimental food stamp plan that would distribute certain surplus food items through regular channels of trade. The plan was to be tried out in six cities with populations of more than fifty thousand. This represented a relatively cautious approach to the paradoxical dual problems of hunger and food surpluses. During the early years of the New Deal and the Great Depression, such a program might have been rushed into operation on a nationwide scale.

The decision to try a food stamp or coupon approach in lieu of direct distribution of commodities was based on the following factors. First, the food stamp approach reflected a desire to match more closely the kinds, varieties, and amounts of foods being made available to low-income families to the actual needs of such families. Second, such a plan was thought to provide more assurance that federal subsidies would actually increase food consumption rather than partially replace previous food expenditures. Third, planners believed that there were inherent advantages in utilizing regular commercial food-distribution channels rather than food banks or charities.

The plan called for the issuance of food stamps to needy persons receiving or certified for public aid. Each such client would be permitted to purchase a minimum value (varying according to size of family) of one type of stamp that could be used to purchase any food product. In addition, clients would receive, free of charge, another type of stamp in an amount equal to 50 percent of the value of the stamps purchased. These supplemental stamps would be redeemable only for certain food commodities. This feature of the plan was intended to guarantee that the free stamps would increase consumption, especially of surplus commodities. According to Secretary of Agriculture Henry A. Wallace, who addressed a meeting of the National Food and Grocery Conference Committee in Washington, D.C., on March 13, 1939, the plan aimed to increase the domestic consumption of surplus food commodities. Issuance of the stamps would create demand for commodities that were surplus not because

the need for them did not exist but because the persons who needed them most could not afford them.

Records of various public health services and studies by the Bureau of Home Economics indicated that malnutrition and undernourishment, particularly of children, were widespread in every U.S. state at that time. These same studies estimated that millions of people in the United States spent an average of \$1.00 or less per week for food. Such low expenditures translated into low prices and surpluses for farmers and into diets for low-income families that were less than the minimum necessary to maintain adequate standards of health. The proposed plan was designed to raise average spending on food to \$1.50 per week per person for those eligible to participate in the program. The plan was heartily endorsed by the National Food and Grocery Conference Committee.

The first food stamp plan established by the U.S. Department of Agriculture began as an experiment on May 16, 1939, in Rochester, New York, and was subsequently extended to five additional experimental areas: Montgomery County, Ohio; King County, Washington; Jefferson County, Alabama; Pottawatomie County, Oklahoma; and Des Moines, Iowa. Secretary of Agriculture Wallace stated that the stamp plan would apply at first only to food but that it might be extended to other goods, cotton products in particular, if it proved to be successful and if satisfactory arrangements could be made with retailers. Wallace also stated that measures such as the stamp plan, with the government subsidizing expanded consumption, were not the most desirable solution to the problem of making abundance work for the American people; he hoped that other solutions ultimately would be found.

The first food stamp program was established through the broad authority contained in Section 32 of Public Law 74-320, passed in 1935. Section 32 permanently appropriated an amount equal to 30 percent of U.S. Customs receipts from all sources each year for the secretary of agriculture, to be spent on three purposes: encouragement of agricultural exports, encouragement of domestic consumption of agricultural commodities, and reestablishment of farmers' purchasing power. Specifically, Section 32 provided that the funds were to be used "to encourage the domestic consumption" of agricultural commodities or products. The secretary of agriculture was

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given authority to pay benefits to low-income people to further the three stated purposes.

The food stamp plan was first administered by the Federal Surplus Commodities Corporation and later by the Surplus Marketing Administration and its successor organizations, the Agricultural Marketing Administration and the Food Distribution Administration of the U.S. Department of Agriculture. The United States was divided into four regions, each with a regional director who was given considerable discretionary powers to carry out program policy and procedures.

A two-color stamp plan was formulated in an attempt to ensure that the federal subsidy actually was used for additional food purchases and to control the kinds of food participants could purchase with the free additional coupons. Participating families were required to exchange an amount of money representing estimated normal food expenditures for orange stamps of the same monetary value. Along with these orange stamps, participants were provided, without cost, additional blue stamps, which they could use to buy designated surplus foods. In this manner, the plan attempted to concentrate the additional purchasing power on surplus foods—that is, foods for which there were marketing difficulties. In 1939, a significant portion of the nation's food supply could be classified in the surplus category. When the program was first begun, the surplus commodities on the blue stamp list were butter, eggs, white and grain flour, cornmeal, oranges, grapefruit, dried prunes, and dried beans. At one time or another the list also included rice, hominy grits, peaches, pears, apples, raisins, peas, tomatoes, snap beans, cabbage, onions, pork, and lard.

Foods were designated as blue-stamp (surplus) food each month by the secretary of agriculture, and a list of the foods designated was sent to participating retail merchants. Participating retailers were required to post notices of these monthly designations in their stores as a means of informing participants of the foods that could be purchased with the blue stamps. It was intended that this posting also would bring these foods to the attention of other customers and thereby encourage increased purchases of the surplus foods among higher-income families not participating in the plan.

Both the orange and the blue stamps were printed in two denomi-

nations—twenty-five cents and one dollar—and resembled postage stamps in design. In fact, an engraver's plate for an old postage stamp was redesigned and used for food stamp purposes. The stamps were issued in books. Participating areas were required to use public funds to establish a revolving fund to purchase the orange stamps from the Department of Agriculture. The revolving fund was subsequently replenished from the proceeds received from the sale of these orange stamps to participants.

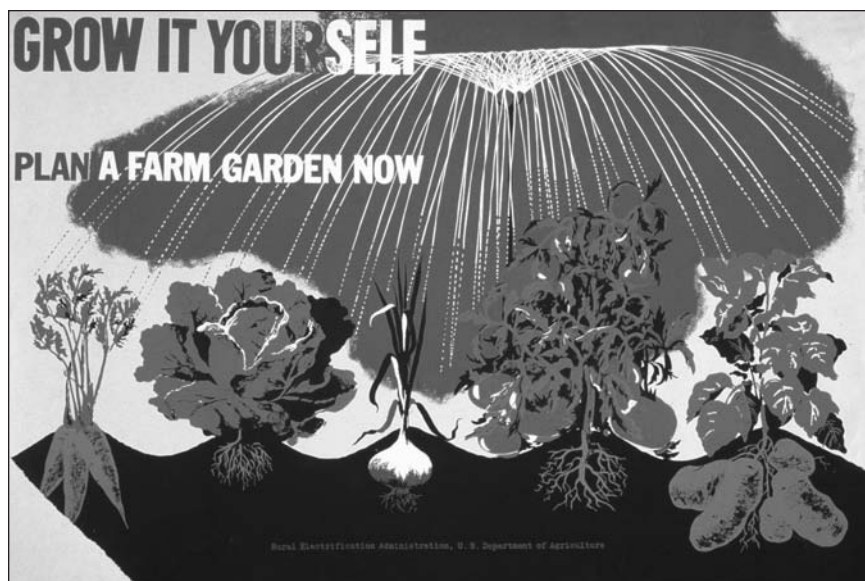
SIGNIFICANCE

As measured by the number of participants, the food stamp plan reached its peak in May, 1941, when approximately four million people participated. New geographic areas were brought into the plan after 1941, but it never operated on a nationwide basis. As measured by the number of geographic areas served by the plan, the peak was reached in August, 1942, when 1,741 counties—about half of the counties in the nation—and eighty-eight cities were included. These areas contained almost two-thirds of the population of the United States, according to the 1940 census. During the forty-six months that the plan was in operation, the additional food purchasing power provided to participants by the federal government was \$260 million.

Surveys and studies indicated that the plan did increase food consumption levels among participating groups. The early plan, however, was believed to have been greatly abused. The Department of Agriculture estimated that 25 percent of all benefits were misused. Some of the same types of abuse were repeated in later food stamp programs. For instance, some stamps reportedly were traded for liquor and tobacco, and some grocers would buy them for cash at a discount, an activity now known as trafficking.

The plan was discontinued in early 1943, when World War II wartime conditions had greatly reduced unemployment and greatly increased demands on U.S. food supplies, thereby removing part of the rationale for the program. Inasmuch as the program was predicated on the existence of surplus foods, the program was terminated as such surpluses turned to scarcity during the early years of U.S. involvement in World War II. The program had been established administratively and never had been explicitly authorized by Congress.

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Federal government poster encouraging Americans to grow their own food crops during World War II. Because their produce helped in the war effort, home gardens became known as "Victory Gardens." (Library of Congress)

Immediately following termination of the plan, two bills were introduced to establish a food stamp, or food allotment, program legislatively: House Resolution 2997, by Representative Christian Archibald Herter (Republican of Massachusetts), on June 18, 1943, and Senate Bill 1331, by Senators George D. Aiken (Republican of Vermont) and Robert M. La Follette, Jr. (Progressive of Wisconsin), on July 8, 1943. An amendment to establish a food stamp program, incorporating the thrust of the Senate bill, was proposed in the Senate on February 10 and 11, 1944, by Senators Aiken and La Follette. The amendment was defeated by a vote of forty-six to twenty-nine. Hearings on the bill itself had been concluded on January 26, 1944, by a subcommittee of the Senate Committee on Agriculture and Forestry.

The U.S. government did not institute another food stamp program until 1961, when a pilot program was undertaken. That program became permanent with the passage of the Food Stamp Act of 1964, but it underwent a number of changes in the latter part of the twentieth century. In May, 2002, the Food Security and Rural Invest-

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Gregory P. Rabb

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■ AUGUST 4, 1942

UNITED STATES BEGINS THE BRACERO PROGRAM

Initiated as a war measure to ensure adequate agricultural labor supplies during World War II, the bracero program continued until 1964, when it was terminated on the basis of alleged negative influences on the employment of domestic workers.

ALSO KNOWN AS: Mexican Farm Labor Supply Program; Mexican Labor Agreement

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Government policy and regulation; Labor; Migration

KEY FIGURES

Claude R. Wickard (1893-1967), U.S. secretary of agriculture, 1940-1945

Franklin D. Roosevelt (1882-1945), president of the United States, 1933-1945

Harry S. Truman (1884-1972), president of the United States, 1945-1953

Willard Wirtz (b. 1912), U.S. secretary of labor, 1962-1969

SUMMARY OF EVENT

The bracero program for importation of Mexican labor into the United States was begun in 1942, in response to the rising complaints of southwestern farmers and railroad shippers of a severe agricultural labor shortage. Agriculturalists argued that the military draft, along with high-paying defense-industry jobs, had drawn large numbers of agricultural workers away from farms at the very time that uninterrupted agricultural production was needed for military success. Without foreign contract labor, they concluded, food shortages were inevitable. Although many economists, most notably Conrad Taeuber, head agricultural economist of the Bureau of Agricultural Economics, disagreed with this view of the agricultural labor market,

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President Franklin D. Roosevelt responded to pressure and opened negotiations with Mexico for temporary contract laborers.

Mexico's initial response was negative. Mexican officials sharply reminded the United States of the long and exploitive history of U.S. relations with Mexican workers. During the Great Depression, the United States had forcibly returned hundreds of thousands of laborers to Mexico in an effort to protect the jobs of American citizens. Unless the United States was willing to accede to a host of procedural safeguards for these temporary workers, Mexico was unwilling to allow its citizens to cross the border. These safeguards included having individual contracts written in Spanish, each with guarantees to pay living expenses and to provide adequate shelter and transportation costs while a worker was in transit.

Workers were further to be protected from all discriminatory acts and were not to be subject to the U.S. military draft. Wages were to be set at an annually determined "prevailing wage" based on the locality in which the laborer was to be employed. Most important, these contracts were between the Mexican and U.S. governments, not the worker and employer. The idea was that the U.S. government, as the primary contractor, would "sublease" the workers' contracts to farmers. This meant that the U.S. government held the ultimate responsibility for ensuring that the contracts' provisions were upheld. It also gave the Mexican government the power to limit the number of workers allowed into the United States if discriminatory practices occurred or if contracts were violated.

Under pressure to act, President Roosevelt agreed to these concessions and, on August 4, 1942, signed an executive agreement initiating the bracero program. Roosevelt drew his authority to initiate the program from the Immigration Act of 1917. Although it specifically prohibited contract agricultural workers, that act allowed the commissioner general of immigration and the secretary of labor to admit otherwise inadmissible persons. Roosevelt then assigned the Farm Security Administration (FSA) of the Department of Agriculture responsibility for administering the program. The program thus fell under the purview of the secretary of agriculture, Claude R. Wickard.

From the start, the bracero program was controversial. Farmers disliked the restrictions imposed on them by the program, particularly the wage provisions, which they saw as a first step toward univer-

sal wage regulations for agriculture. They also distrusted the FSA, which they believed was generally in opposition to farmers. At the same time, labor disliked the program as run by the FSA because of its lax rules as to the setting of the “prevailing wage.” Ideally, the “prevailing wage” in a region was to be set by the market. Where labor was scarce, wages were expected to rise. Only where labor shortages existed after wages rose were braceros to be allowed. In practice, however, the FSA allowed farmers to set the “prevailing wage” at the beginning of the growing season, and if this wage was inadequate to attract enough domestic workers, the farmers were allowed to bring in braceros.

In April, 1943, dissatisfaction with the FSA resulted in passage of Public Law 45, 78th Congress, in which Congress gave its approval to the bracero program. In doing so, however, Congress significantly reshaped the operation of the program. Public Law 45 removed the FSA as administrator of the bracero program, giving this authority to the Cooperative Extension Service (CES). This presumably was done to satisfy the complaints of large growers about the FSA. The CES was also a part of the Department of Agriculture, but unlike the FSA it was historically allied with large growers and shippers. In addition, the wage and working-condition provisions of the original executive order were not included in Public Law 45. Although the government would still hold contracts with individual braceros, it would not have the power to demand the application of a “prevailing wage.” Instead, the power to set wages was, in effect, returned to farmers. In practice, farmers had always had the power to set wages; this law merely formalized the process.

Following the end of World War II, the original justification for the bracero program ended. On December 31, 1947, so too did the executive agreement between the United States and Mexico. Public Law 45, however, remained on the statute books, authorizing the use of braceros if the U.S. government wished it. Harry S. Truman’s administration did. On February 21, 1948, a new labor importation agreement was concluded with Mexico. In following years, similar annual agreements would be signed. The post-1948 agreements also drew their authority from the 1917 Immigration Act. There were, however, a few significant differences between the new agreements and those from wartime. The U.S. government would no longer be

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the employer of record for braceros. Instead, individual growers or growers' associations contracted directly with Mexico for bracero workers. This meant that the government was no longer legally responsible for the fulfillment of bracero contracts.

This provision of the post-1948 agreements was to bring a further change in the bracero program in 1951. Angered over repeated violations of contract provisions by U.S. farmers, and empowered by the growing demand for immigrant labor resulting from the Korean War, the Mexican government demanded that the U.S. government reacquire control over bracero contracts. Congress responded on July 12 with An Act to Amend the Agricultural Act of 1949, which returned the bracero program to operating on a government-to-government basis and thus placed the responsibility for guaranteeing that the provisions of bracero contracts were met directly with the U.S. government. With this change in place, the postwar bracero program was complete. It continued unchanged until 1964.

The reformism of the New Frontier and the Great Society finally killed the bracero program. Both the John F. Kennedy and Lyndon B. Johnson administrations thought that braceros cost American workers jobs and permitted farmers to keep agricultural wages low. Without braceros, the reasoning went, farmers would have to raise wages if they wanted to hire enough workers to pick their crops. In 1961, President Kennedy ordered Secretary of Labor Arthur Goldberg to look into ways to protect domestic workers. Goldberg's successor, Willard Wirtz, recommended that the program, which came up for renewal in 1964, not be renewed. On December 31, 1964, the bracero labor importation program was allowed to expire.

SIGNIFICANCE

There is little doubt that the bracero program had effects on the agricultural sector of the United States both during and after World War II. By the end of 1947, when the first bracero program ended, some 220,000 workers had been recruited under the program. In the years following, the annual number of braceros working on U.S. farms ranged between 50,000 and 350,000. This many contract laborers could not help having an impact both on the agricultural output of the nation and on working conditions in the agricultural sector. It is difficult to say, however, how significant their impact was.



Mexican farm workers being processed at the labor center in Hidalgo, Texas, for employment under the Bracero program during the late 1950's. (AP/Wide World Photos)

During World War II, for example, braceros made up only a part of the total number of Mexican laborers working on U.S. farms. In reaction to Texas's historic discrimination against Hispanic people, Mexico refused to contract any braceros to Texas for the first five years of the program. This meant that Texas farmers had to use either domestic laborers or illegal immigrant workers. Many Texas farmers chose illegal workers, even after Mexico allowed braceros to contract in Texas.

Following the war, the use of illegal workers by many U.S. farmers, in preference to both braceros and domestic laborers, continued. During the mid-1950's, the immigration enforcement mechanism became overloaded. Tens or even hundreds of thousands of illegal immigrants were deported every year. They made up only a fraction of the "wetbacks" (a term then used in legal documents) actually working on U.S. farms. Only with Operation Wetback, a multi-

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department, multiyear effort by the U.S. and Mexican governments to halt the flow of illegal immigrants northward, did the number of such laborers working on U.S. farms decrease, and then only temporarily.

Given the large number of illegal workers on U.S. farms during the period in which the bracero program operated, it is difficult to argue that the bracero program had any significant effect in raising agricultural wages. In fact, the opposite seems more plausible. Wartime problems with the “prevailing wage” system worsened following the war, when contracting powers were placed directly in the hands of farmers. The return of the U.S. government as official contractor of braceros after 1951 did not bring much effective change in the wage-reducing effects of the bracero program. Throughout the period, agricultural wages remained low in comparison to those in other sectors of the economy.

As late as 1964, the Mexican government continued its support of the bracero concept. It believed that the program provided significant protections to Mexican workers in the United States that would be absent without a formal agreement. It also worked to improve relations between the United States and Mexico and helped improve working conditions on U.S. farms for both Mexican and domestic workers. The program also helped keep the already troublesome problem of illegal immigration from getting worse.

Charles Zelden

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■ 1943-1944

FAMINE DEVASTATES BENGAL

Famine hit the region of Bengal, India, and took the lives of an estimated three million people. Bengalis died from starvation, malnutrition, and other illnesses caused by food shortages, crop failure, and other factors.

LOCALE: Bengal, India (now state of West Bengal and independent Bangladesh)

AGRICULTURAL ISSUES: Disease and health issues; Famine and hunger; Flooding; Natural disasters

KEY FIGURES

John Herbert (1895-1943), governor of Bengal, 1939-1943

Huseyn Shaheed Suhrawardy (1892-1963), member for civil supplies, Bengal government, and premier of Bengal

Archibald Wavell (1883-1950), British field marshal, viscount, and viceroy of India, 1943-1947, and later first Earl Wavell, 1947-1950

SUMMARY OF EVENT

A combination of circumstances led to one of the worst famines in modern world history. First, the British, having long occupied and ruled the Middle East, fed their troops in the region (fighting in battles of World War II) by exporting food from India; rice was a major food source not only for the troops but also for the region's populations. To meet demands, the government of India bought the crops as they were harvested, leading to limited supplies of rice for the general population.

Significantly, Japan joined the war when it bombed Pearl Harbor in Hawaii on December 7, 1941. The Japanese then invaded Southeast Asia and captured Singapore and then Malaysia and Burma, which were all part of the British Empire. Burma (now Myanmar) was especially critical for the British, who had developed the Irrawaddy Delta and Arakan (now Rakhine) after 1885 as great rice-producing areas. More than 20 percent of the rice consumed in Bengal had been imported from Burma. With the Japanese capture of Burma came the end of all imports of rice from that area, causing rice short-

ages in Ceylon (now Sri Lanka). Ceylon imported large amounts of rice from Burma; it also was the headquarters of the British army's southeast Asia command. Rice was exported from India to Ceylon, causing a further tightening of supplies in India.

Second, on October 16, 1942, northeast India was hit by a cyclone that devastated Bengal and neighboring Orissa. The land was flooded for some 40 miles between the coast and prime rice-growing areas inland, leading to the failure of the entire fall rice crop and to farmers having to eat their surplus rice and seed to survive. As of May, 1943, no rice seed had been planted. The situation for peasants in Bengal became critical. Food prices skyrocketed, making the purchase of food beyond the means of many people.

A third factor involved in the famine was the epidemic of *helminthosporium oryzae*, or brown spot disease, that broke out during the ideal conditions that followed the cyclone and flooding. In two areas of Bengal, Bankura and Chinsurah (now Hooghly-Chinsura), only 10 percent of the crop survived. As a result of the disease, the rice yield in 1942 was exceptionally low. The disease, and the resultant shortage of rice, has been blamed for causing the famine, although this claim has been disputed, especially by Indian nationalist historians who wish to put the blame completely on British administration.

The final ingredient in the famine was the human factor, which took several forms. The first was the hoarding of supplies by black marketers and others to drive the price of rice to exorbitant levels and then to sell the higher-priced food for enormous profits. By December, 1942, the price of rice had doubled from its 1939 level. The shop windows of bakeries in Calcutta (now Kolkata) were filled with high-priced cakes and pastries, which the starving could not afford. The Bengali government under Huseyn Shaheed Suhrawardy, who was widely criticized in the Hindu and the Western press for the famine, went on a "food drive" to search for stocked rice and force its sale. Suhrawardy, however, had been slow to introduce rationing in Calcutta and to ship rice to the rural areas. On his food drive, he found a considerable amount of rice, but the stock had little impact on the destitute. Another "human" factor in the famine was that Bengalis were not used to eating wheat, which could have been imported, at great price, from other provinces of India. Bengalis would slowly adopt the custom of eating bread, but bread con-

sumption had little positive impact on the hungry in 1943 and 1944.

Suhrawardy, who was a Muslim, appointed a Muslim businessman to be the agent responsible for importing rice into Bengal. This aroused the animosity of the Hindus. When Suhrawardy traveled to Delhi to persuade the government of India to demand that the other rice-producing provinces of India export rice to Bengal, the Hindu premiers of those provinces resisted on communal grounds. To clear accusations of bias against him, Suhrawardy hoped to appoint Hindu agents but was roundly criticized by his Muslim colleagues. He worked indefatigably to ameliorate the crisis but received only criticism for his efforts, both from the Hindu press and from the British. The governor of the province, John Herbert, proved to be an ineffective administrator. He became ill and was replaced by an acting governor on September 6, 1943.

The human factor was also manifested politically. Calcutta, the largest city of India, had a high priority to receive supplies of all kinds to prevent the city's influential intellectual classes from becoming disaffected. The government channeled all commodities, including food, to the city at the expense of the hinterlands. Of the eighty-six subdivisions of Bengal, fifteen (located in the south and east) were severely affected by the famine. The people of these divisions, mostly older men and women and children, began to migrate to Calcutta in July to search for food. By October, more than 150,000 people were destitute and begging for food in Calcutta. The British system of administration made the situation worse because it did not allow the free flow of food among the provinces of India, leading to even more of a food shortage. The government would not allow food from the other provinces of India to be sent to Bengal.

The famine continued to ravage Bengal into the early months of 1944 and ended only with the recovery of the rice crop in 1944. The viceroy of India, Archibald Wavell, traveled to Bengal and began a vigorous effort to mitigate the effects of the famine. He did so within a week of assuming the viceroyalty. He called a meeting of provincial governors and asked for their cooperation and support, persuaded the Bengali government to move the destitute out of Calcutta and into camps so that the army could feed them, supplied rural areas with food grains, ordered rationing in Calcutta, and badgered an indifferent British government in London to supply India with food.

SIGNIFICANCE

The famine caused untold hardship and misery to the poor people of Bengal, killing as many as three million and affecting millions of others through malnutrition and lower resistance to disease. The number of people whose lives were shortened because of the famine is impossible to know.

Politically, the Bengal famine damaged British prestige in India incalculably and was one of the factors that led to deepening opposition to British rule in India. Four years after the onset of the famine, British rule in India ended.

Roger D. Long

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■ MAY 18-JUNE 3, 1943

UNITED NATIONS HOSTS FIRST CONFERENCE ON FOOD AND AGRICULTURE

During World War II, representatives of forty-four nations met to discuss improving the living standards of the world's hungry poor by influencing scientific, technological, and economic aspects of world food production and trade. The Food and Agriculture Organization of the United Nations was formed at this conference, which was called by U.S. president Franklin D. Roosevelt at the urging of First Lady Eleanor Roosevelt.

ALSO KNOWN AS: Food and Agriculture Organization of the United Nations; Hot Springs Conference

LOCALE: Hot Springs, Virginia

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Famine and hunger; International food relief; Marketing and trade; Scientific research

KEY FIGURES

Franklin D. Roosevelt (1882-1945), president of the United States, 1933-1945

Eleanor Roosevelt (1884-1962), First Lady of the United States, 1933-1945, who urged the president to call the conference

Frank L. McDougall (1884-1958), Australian proponent of economic policy for food security

Stanley Bruce (1883-1967), former prime minister of Australia, 1923-1929, and first independent chairman of the Food and Agriculture Organization council

Lester B. Pearson (1897-1972), chairman of the interim commission and later prime minister of Canada, 1963-1968

SUMMARY OF EVENT

In his now-famous Four Freedoms state of the union address in 1941, President Franklin D. Roosevelt declared four essential human freedoms, including “freedom from want . . . everywhere in the world.”

NATIONS REPRESENTED AT U.N. CONFERENCE ON FOOD AND AGRICULTURE

- | | |
|------------------------|--|
| • Australia | • Iceland |
| • Belgium | • India |
| • Bolivia | • Iran |
| • Brazil | • Iraq |
| • Canada | • Liberia |
| • Chile | • Luxembourg |
| • China | • Mexico |
| • Colombia | • Netherlands |
| • Costa Rica | • New Zealand |
| • Cuba | • Nicaragua |
| • Czechoslovakia | • Norway |
| • Denmark (unofficial) | • Panama |
| • Dominican Republic | • Paraguay |
| • Ecuador | • Peru |
| • Egypt | • Philippines |
| • El Salvador | • Poland |
| • Ethiopia | • Union of South Africa |
| • France | • Union of Soviet Socialist
Republics |
| • Great Britain | • United States of America |
| • Greece | • Uruguay |
| • Guatemala | • Venezuela |
| • Haiti | • Yugoslavia |
| • Honduras | |

Just two years later, after war had broken out around the world, Roosevelt called a conference on food and agriculture to be held from May 18 to June 3, 1943. Warfare, however, made international travel difficult and dangerous. When Roosevelt asked nations to send representatives to the conference, forty-four sent delegates. Because the conference predated the formation of the United Nations, the forty-four countries were mainly associated with the Allied Powers of the United States, Canada, and the United Kingdom during World War II.

Nutrition, the scientific study of how calories, vitamins, and nutrients affect human health, was still a relatively new science during the early twentieth century. Increasing knowledge of nutrition created the idea that a nation, by promoting good nutrition and food produc-

tion, could improve the health, living standards, and productivity of its citizens and the citizens of less developed nations. With new standards of adequate nutrition, malnutrition was exposed in populations of every nation of the world, even the affluent. Malnutrition proved to be a symptom not only of agricultural shortcomings but also of problems in infrastructure and trade, economics, dissemination of information, and the governance of nations.

The International Institute for Agriculture (IIA), established in 1905, was the first intergovernmental organization devoted to studying agricultural productivity. Headquartered in Italy, the IIA gathered agricultural statistics, funded research and development, organized international conferences, and published technical and statistical reports. Political turmoil in Europe surrounding World War I, the Great Depression, and World War II led the IIA to mold.

Even while the storm of World War II was gathering, several publications linking economics and nutrition catalyzed an interest in food and agriculture as a means of improving living standards. As a member of the League of Nations, Frank L. McDougall began working with American and British nutritionists to establish political policy on nutrition. In 1935, McDougall analyzed the dire findings of these specialists and wrote *The Agricultural and the Health Problems*. Stanley Bruce, a leading proponent of food security, addressed the league on the same topic in 1935. Bruce, who was an outspoken complement to McDougall's persistent academic presence, would later have a leadership role in the Food and Agriculture Organization (FAO) of the United Nations. In 1937, the league published another report that was widely read across the world: *The Relation of Nutrition to Health, Agriculture, and Economic Policy*. This publication became a best seller among league documents. *The New York Times* editorialized it as a book of the year, and several nations, including Germany, implemented its ideas. At the time these items were published, the Great Depression—with its simultaneous surpluses and famines—was fresh in the memory of world leaders and citizens. Unfortunately, World War II erupted before the league committed to a plan of action in nutrition.

McDougall, who continued to research and write extensively to promote solutions for food insecurity, produced a memorandum for the U.S. Department of Agriculture (USDA) on international



Germans searching for food in a Berlin garbage dump in 1945. The problem of hunger reached crisis levels in Europe after the conclusion of World War II.
(Library of Congress)

food problems. Called “Draft Memorandum on a United Nations Programme for Freedom from Want of Food,” the memo was privately distributed in October of 1942. McDougall stated that more than half the world’s laborers work in agriculture; food, he added, would be a major preoccupation after the war. By this time, World War II had disrupted productivity and food trade routes across the continents. The war had been forcing many nations to think about nutrition policy. Government food rationing would become necessary to ensure survival of civilians and troops during a time of decreased productivity, disrupted trade, and inflated prices.

Eleanor Roosevelt, after reading McDougall’s memo, arranged a meeting in response. She encouraged President Roosevelt to organize a conference. Despite the perils of travel, forty-four nations sent representatives to Hot Springs, Virginia, from May 18 to June 3, 1943.

Roosevelt named Judge Marvin H. Jones, the United States’s war-time food administrator, the chairman of the Hot Springs Conference. The initial goals for Hot Springs included laying the foundations for a permanent intergovernmental organization for developing nutritional and agricultural policies for member states.

MAY 18-JUNE 3, 1943

Many of the participating nations sent topical specialists—namely in agriculture, trade, and statistics—rather than strictly diplomatic representatives. Consequently, scientific and economic subjects were covered along with political subjects. Participants made recommendations on nutrition, malnutrition and disease, the formation of national organizations, the exchange of information and technology, the gathering and dissemination of statistics, research, cooperative efforts in water and land management, and international security for food production and trade. Politically tense topics included a funding structure for the organization, provisions for market control, and consequences for both food-producing and food-importing countries. Conference attendees, however, agreed on the major goals of improving national diets, increasing food production, disseminating technical and scientific knowledge, and creating a permanent international organization. The name Food and Agriculture Organization of the United Nations (FAO) was established.

The Interim Commission on Food and Agriculture, charged with creating “a specific plan for a permanent organization in the field of food and agriculture,” also was formed at the conference. Each of the original forty-four participating countries was allowed one representative for this commission; Lester B. Pearson, a Canadian diplomat and politician, was made the chairman.

The interim commission’s first charge was to draft the FAO constitution. It planned the scope of activities for the Food and Agriculture body of the United Nations. The commission’s first report to participating nations included the draft constitution. When the constitution was acceptable to the forty-four nations, the FAO would have its first official conference.

The interim commission established committees and subcommittees to prepare reports on important topics, including nutrition and food management, agricultural production, fisheries, forestry, and statistics. Forestry was not originally discussed at the Hot Springs Conference, but it was advanced by the interim commission. The commission also recommended that the IIA be merged into the new FAO. With the signing of the FAO constitution at the first session of the Food and Agriculture Conference in Quebec in 1945, the Hot Springs Conference goals came to fruition and the FAO was formed as a specialized U.N. agency.

SIGNIFICANCE

The problems of wars and famine that haunted the first half of the twentieth century brought food and hunger to the forefront of policy makers' consciousness. Contemporary developments in economics, agriculture, and nutrition paved the way for food policies that could improve living standards for all on an international level. These advancements, combined with the twentieth century interest in the development of intergovernmental agencies, made the FAO a flourishing entity.

The FAO, the first specialized agency of the United Nations, has improved awareness of and standards for nutrition, particularly among rural and poorer nations. The FAO continues to promote scientific and economic initiatives in peacetime, and it organizes humanitarian relief in times of drought, famine, and war. The FAO has grown to be the largest agency in the U.N. system, with 180 member states and more than 4,300 employees.

Jessica M. Efron

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SEE ALSO: September, 1944: Borlaug Begins Work on High-Yield Wheat; February, 1962: United Nations Establishes World Food Programme; November 16, 1974: United Nations Issues Declaration on Hunger and Malnutrition.

■ SEPTEMBER, 1944

BORLAUG BEGINS WORK ON HIGH-YIELD WHEAT

Norman Borlaug developed the first high-yield wheat crops, which increased food production dramatically. Borlaug's work changed the structure of agriculture worldwide by the 1960's and helped alleviate hunger in impoverished nations.

LOCALE: Mexico

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Fertilizers; Genetic engineering; Mechanization; New crops and food products; Scientific research

KEY FIGURES

Norman Borlaug (b. 1914), American plant pathologist

Manuel Avila Camacho (1897-1955), president of Mexico, 1940-1946

Jacob George Harrar (1906-1982), American plant pathologist

SUMMARY OF EVENT

In September, 1944, Norman Borlaug, a young plant pathologist from Iowa, arrived in Mexico City to join a team of American agricultural scientists invited by the Mexican government to improve crop yields there. Jacob George Harrar, who headed the team, initially assigned Borlaug to work on corn, but when Harrar's administrative duties increased, he assigned Borlaug the research on wheat as well. It was through the work on wheat that Borlaug revolutionized agriculture in Mexico and eventually throughout much of the developing world.

The invitation issued to the American scientists signified a change in the agricultural policy of the Mexican government. Manuel Avila Camacho had just been elected to the presidency. The previous administration had adopted policies of giving land to farmers and cooperatives and of improving traditional farming practices. Avila Camacho, on the other hand, was interested in agriculture that would aid industrial growth in the cities. This entailed abandoning

NORMAN E. BORLAUG

An American agronomist and plant pathologist, Borlaug received his bachelor's (1937), master's (1941), and doctoral (1942) degrees from the University of Minnesota in plant pathology and forest management. Afterward, the Rockefeller Foundation hired him to breed disease-immune crops that could grow in Mexico's varied ecosystems. He developed a high-yield dwarf spring wheat. In response to German bacteriologist Paul Erhlich's 1968 prediction that the world would soon face massive famine, Borlaug concluded that high-yielding crops could avert catastrophe. In 1963 the Rockefeller Foundation and Mexico established the International Maize and Wheat Center, which Borlaug headed. By 1968, he had increased Pakistan's wheat yield by 70 percent and ushered in the Green Revolution, which saved millions of lives and won him a Nobel Peace Prize in 1970. Controversy about the impact of his scheme on the environment followed, however, because of the necessity of using inorganic fertilizers and irrigation to achieve the higher yields. Borlaug responded that with higher production yields per acre, less land fell victim to slash-and-burn agriculture, more than offsetting the environmental stresses of his methods.

traditional methods in favor of capital-intensive technologies. Improved seeds were the key to this effort.

The land redistribution of the previous administration and the nationalization of certain sectors of industry, including an oil subsidiary owned by the Rockefeller family, had so alarmed Washington that U.S. investment in Mexico had dropped 40 percent. The U.S. government, however, supported Avila Camacho. When he asked the United States for help in developing a comprehensive agricultural plan, President Franklin D. Roosevelt, then preoccupied with preparations for entering World War II, sought help from the Rockefeller Foundation. The foundation chose Harrar, previously the head of plant pathology at Washington State University, to write up a report, on the basis of which a joint agricultural program was established by the Rockefeller Foundation and the Mexican Ministry of Agriculture.

Borlaug was a plant pathologist heading a Du Pont biochemical lab when he was drafted for the program. When he arrived in Mexico, Borlaug was shocked at the poverty and hunger he observed. Al-

though it planted ten million acres with corn and one million acres with wheat, Mexico imported 100 million pesos (30 million dollars) worth of wheat alone every year. Borlaug was convinced that higher-yield crops were the answer.

One of the chief obstacles he faced was rust, a disease prevalent in the Mexican wheat fields. To increase yields, Borlaug had to breed resistant seeds. He worked in experimental plots at Chapingo, near Mexico City, cross-pollinating plants with the best yields with those with the best disease resistance, a painstaking procedure that had to be performed by hand. Initially, he worked with Mexican and U.S. wheat varieties, but within two years, as his work became known, thirty-eight varieties from around the world were available to him.

Impatient with the time necessary for each test batch to mature, Borlaug went against conventional practice to set up a second test site in Puebla. He carried his just-harvested crop from the lowland location to the highland to grow two generations of wheat each year. Because of the differences in environment and length of day between his two sites, the seeds became highly adaptable to a wide range of growing conditions.

Borlaug's methods met some resistance from his own U.S. team and even more from the Mexican farmers he was trying to influence, particularly on the issue of fertilizer. Unless large doses of fertilizer were used, the new seeds performed less well than the old, and Mexican farmers were not accustomed to using fertilizer. The hybrids also needed a constant water supply, making irrigation necessary on an unprecedented scale. In addition, for high yields to be achieved, the traditional small fields containing a mix of many different food crops had to be replaced with dense stands of the high-yield variety. Machinery became necessary for plowing and harvesting, and the majority of farmers were unable to afford these innovations. Initially, Borlaug's program was authorized to dispense subsidized seed and fertilizer, thus overcoming some of the resistance to the techniques he espoused.

Within two years, Borlaug had bred crops with improved yields and had persuaded a number of Mexican farmers to try them, but neither task was complete. One stumbling block was that when fertilizer doses were increased, the stems of most wheats grew so tall that

they broke easily. This problem was solved in 1953, when Borlaug was sent a hybrid bred from a Japanese variety with a short stem, or straw. This dwarf plant could direct all its energy into increased grain production. The discovery of the Japanese wheat was a breakthrough. Borlaug's work on the problem of rust, however, was ongoing, because new strains of the disease broke out continually.

In 1964, scientists at Purdue University discovered a mutation in corn that had double the normal amount of lysine. Lysine was the key to increasing the amount of protein in the edible portion of the plant. When Borlaug heard of this discovery, he turned his attention to increasing the protein content of other grains. This led him to persuade a Canadian, Frank Zillinsky, to work for him on triticale, a cross between wheat and rye that had the potential to be a good high-protein crop if it could be bred to be fertile. Zillinsky achieved that goal in 1967.

Borlaug recruited a corps of students from Mexican agricultural colleges to help him with his work. These young people were better able to communicate with local farmers than was Borlaug, and they were of tremendous assistance in the rapid spread of the new hybrids and the farming techniques that went with them.

By 1953, as a direct result of Borlaug's work, Mexico had doubled its wheat production. By 1956, it stopped importing grain. The costs of production (machinery, tools, fuel, and fertilizer) had doubled in six years, but yields had tripled and Mexicans were eating 40 percent more food on average. By 1963, 95 percent of Mexico's wheat crop was in Borlaug's semidwarf varieties.

Hunger still had not been eradicated in Mexico. In part this was a result of the social changes brought about by the new seeds. Smaller farmers given subsidized inputs initially were more responsive to Borlaug's ideas. When large landowners saw what his seeds could do, however, they were converted, and they were in a better position to buy the necessary fertilizer, pesticides, water, machinery, and fuel. Specialized knowledge necessary to understand the new techniques and equipment was more available to the better-educated and wealthy Mexican landowners.

Small farmers could not keep up. As they lost their land, large landholders bought it. Their holdings increased rapidly during this period. By 1978, the average size of a farm in Hermosillo, where the



Wheat field. (©Franku/Dreamstime.com)

“miracle” seeds had taken hold, was two thousand irrigated acres. The landless farmers fled to the cities or became laborers for hire in the countryside, in either case with little cash available for food. Therefore, although Mexicans ate 40 percent more food on average, the Mexicans who needed food most did not always get it.

Another reason that hunger continued was that Borlaug had only secondarily turned his attention to the content of the yield he had set himself to increase. Protein in the new crops often failed to match that in the old crops. Furthermore, Mexicans historically ate corn rather than wheat. This corn had been eaten in conjunction with beans, which were planted in the same fields, and together provided an exceptionally balanced protein. The new wheat monoculture replaced these mixed patches, with the result that the diet of the average Mexican became less nutritious.

Mexican farmers soon discovered that the new farming methods could be applied to nonfood crops such as cotton, feedgrain for livestock, and wine grapes. Some land that had been used to produce food for Mexicans was no longer used for that purpose, and a 25 percent drop in food production occurred between 1968 and 1978. The Mexican government responded by increasing price guarantees by

112 percent between 1970 and 1975 to try to keep growers producing food staples, but even then the acreage of land used for those products declined.

The hybrids continued to be vulnerable to pests and diseases. Borlaug and his teams of Mexican scientists bred their new seeds with local, disease-resistant specimens, but the diseases and pests continued to breed and change, and when they struck, they devastated entire crops of the genetically identical seeds. As a result of this combination of factors, as well as of continued population growth, Mexico again became an importer of food staples. Between 1973 and 1976, early childhood death from malnutrition rose 10 percent.

SIGNIFICANCE

Despite these drawbacks, Borlaug's work was considered so successful that in 1959 Harrar and other scientists established an institute in the Philippines where work would be modeled on Borlaug's work in Mexico. The goal was to develop a high-yield variety of rice, the staple food in Asia. The International Rice Research Institute, as it came to

THE HERITAGE SEED MOVEMENT

Modern hybrid seeds have increased yields and enabled the tremendous productivity of the modern mechanized farm. However, the widespread use of a few hybrid varieties has meant that almost all plants of a given species in a wide area are almost identical genetically. This loss of biodiversity, or the range of genetic difference in a given species, means that a blight could wipe out an entire season's crop. Historical examples of blight include the nineteenth century Great Potato Famine of Ireland and the 1971 corn blight in the United States.

In response to the concern for biodiversity, there has been a movement in North America to preserve older forms of crops with different genes that would otherwise be lost to the gene pool. Nostalgia also motivates many people to keep alive the varieties of fruits and vegetables that their grandparents raised. Many older recipes do not taste the same with modern varieties of vegetables that have been optimized for commercial considerations such as transportability. Thus, raising heritage varieties also can be a way of continuing to enjoy the foods one's ancestors ate.

be known, was also funded by the Rockefellers as well as by the Ford Foundation.

In 1960, Borlaug attended a meeting in Rome on the status of wheat and barley hybrids in the Middle East, the Far East, and India. Afterward, he traveled through those regions. As a result, Borlaug proposed creating teams of young local agriculturalists as he had in Mexico, and the United Nations Food and Agriculture Organization (FAO) adopted his idea as part of its international wheat program. Rockefeller funding was obtained to execute the plan.

By 1971, in addition to the Rice Institute in the Philippines, organizations modeled on Borlaug's work in Mexico had been founded in Colombia, Nigeria, Peru, India, Liberia, and Lebanon. The accomplishments of these organizations are known collectively as the Green Revolution, in which traditional agricultural ecosystems around the world were replaced by ones modeled on U.S. industrial agriculture, accompanied by vast social reorganization. In 1970, Borlaug received the Nobel Peace Prize in recognition of his life's work.

Maya Muir

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■ MID-1940'S

FIRST MODERN HERBICIDE IS INTRODUCED

The herbicide 2,4-D was developed to kill broad-leaved plants but not grass and related grain crops, making it an important weed killer and making efficient, targeted weed killing possible on a large scale.

ALSO KNOWN AS: 2,4-dichlorophenoxyacetic acid; 2,4-D

LOCALE: United States

AGRICULTURAL ISSUES: Botany; Chemistry; Ecology and environment; Pests and pesticides; Scientific research

KEY FIGURES

E. J. Kraus (fl. mid-twentieth century), professor at the University of Chicago who helped develop 2,4-D

John F. Lontz (fl. mid-twentieth century), Du Pont Corporation scientist

Harold B. Tukey (fl. mid-twentieth century), research scientist at Michigan State University who made important contributions to the study of 2,4-D

SUMMARY OF EVENT

Humans have been at war with weeds since humankind ceased living as hunter-gatherers and became agriculturalists thousands of years ago. Weeds may be defined as plants growing in places where humans do not want them to be. This may be in the middle of an ornamental flower garden or in farm fields with food crops. The first case is an annoyance to individuals; the second may bring about crop failure and lower the chances of human survival, for weeds not only decrease crop yields but also lower crop quality.

Weed killing in agriculture involved laborious tilling by hand until the development of herbicides, substances that kill weeds. As any home gardener knows, tilling is laborious, expensive, and time-consuming. Before 2,4-dichlorophenoxyacetic acid (2,4-D) became widely used during the late 1940's, it was estimated that weeds diminished agricultural revenues of the United States by more than \$3 bil-

lion per year. At that time, weed removal by tillage made up 20 to 35 percent of the entire cost of most successful agricultural endeavors.

At the time 2,4-D was introduced during the mid-1940's, herbicides such as sulfuric acid, sodium chloride, sodium chlorate, and arsenic compounds had been used for about fifty years. The biggest advantage of 2,4-D in comparison with the other known herbicides was that it could be used in tiny amounts and with relative safety. For example, one water spray form of 2,4-D used one part herbicide per one thousand parts of water. Furthermore, 2,4-D during the 1940's cost only three to eight dollars per acre, compared with fifty dollars or more per acre for any of the other herbicides. Thus, 2,4-D was consequently viewed as being both inexpensive and safe.

Unlike the other types of herbicides, 2,4-D, the most widely used of the weed-killing substances known as the chlorophenoxy herbicides, is a growth regulator that requires only tiny quantities to turn weeds into plants no longer suited to living in their environment. One pound of 2,4-D can replace tens or even hundreds of pounds of most other herbicides. The herbicide is, moreover, simple and inexpensive to produce.

In its pure form, 2,4-D is a white, odorless, and noncorrosive powder that is relatively easy to handle and apply. Because the pure form does not dissolve in water, its application to plants generally requires mixing with oils. Alternatively, 2,4-D can be applied as a water spray, in which case it is first converted into water-soluble forms called esters and amines.

Such water-based forms of 2,4-D are frequently used, although they are usually somewhat more expensive than the pure, unaltered substance. One advantage of the "oil forms" of 2,4-D is that they are not easily washed off the weeds by rain. Rainfall twenty-four hours after the application of the water-soluble forms of 2,4-D very markedly decreases their herbicidal effectiveness. Because there are advantages to 2,4-D preparations both as oils and as water sprays, many different preparations of this herbicide are commercially available.

The discovery of 2,4-D was a product of the extensive search for selective herbicides that arose from discovery of the first such chemicals, the industrially produced nitrophenols and chlorophenols, and the plant hormone indoleacetic acid. The chemical structure of 2,4-D combines features of both of these types of herbicides, making it a widely used weed killer with many applications.

The herbicidal value of 2,4-D was first observed during a systematic study of insecticides carried out by U.S. Department of Agriculture experts from universities across the country. On the basis of their research, the Du Pont Corporation and other companies obtained patents for different forms of 2,4-D. John F. Lontz of Du Pont was the lead scientist in developing a patentable form of the herbicide for that company.

Low concentrations of the herbicide were shown to cause rapid and distorted plant growth, followed soon thereafter by death, when applied to many of the broad-leafed plants that are costly agricultural pests, including wild mustard, Canada thistle, and black bindweed. In contrast, 2,4-D at low concentrations does not affect grasses and thus does not harm grain crops. This is not true of higher doses, which can harm crop plants, so 2,4-D must be applied carefully to crops.

Among the other useful properties of 2,4-D is its relatively quick disappearance from the soil, within sixty to ninety days after its spray application. Several researchers on the original 2,4-D development panel reported that 2,4-D ingestion by cattle, and by the researchers themselves, caused no ill effects—but, of course, any chemical that kills living things has the potential to be toxic to humans. *The Merck Index* (1976) points out that human contact with large amounts of 2,4-D can cause eye irritation and gastrointestinal disturbances, and that high concentrations are lethal to rodents. Although toxic doses



Canadian thistle.
(©Cvoogt/
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Wild mustard flowers. (©Joellen Armstrong/Dreamstime.com)

are much higher than those used herbicidally, weed killers and insecticides should always be used cautiously.

SIGNIFICANCE

One tremendously important consequence of 2,4-D use was the rapid burgeoning of agricultural crops, which led to huge increases of annual production and billions of dollars of profit, kept U.S. food prices down (contrary to expectation), and increased America's power as an agricultural nation. At the same time, U.S. citizens were ensured adequate nutritional intake, and the probability of a U.S. famine was greatly lowered. Similar consequences have been seen in other industrialized nations that use 2,4-D.

Still unresolved, however, is the question of whether 2,4-D and its breakdown products will cause environmental problems and health problems to those who eat foods that contain traces of these substances. It is clear, however, that unlike the persistent insecticide dichloro-diphenyl-trichloroethane (DDT), 2,4-D lingers in the environment only briefly, which should make negative consequences from the herbicide's use much less extensive.

Another important effect of 2,4-D has been its great ability to kill poison ivy, ragweed, and many of the other plants that cause hay fever

and associated respiratory allergies. The herbicide has been sprayed widely on roadsides and in empty lots, which has reputedly had beneficial results. It has yet to be shown that 2,4-D causes health problems when sprayed for this purpose or when sprayed on golf courses and lawns.

A major negative effect of 2,4-D was caused by its very close relative, trichlorinated phenoxyacetic acid (2,4,5-T), which is a very potent defoliant and killer of woody plants such as underbrush and trees. When it was found that a mixture of 2,4-D and 2,4,5-T produced various compound herbicides useful for clearing land, the U.S. military purchased huge quantities of one combination that was shipped in bright orange drums and very soon named Agent Orange. This chemical was used during the Vietnam War to defoliate the Vietnamese jungle and thus to help locate Viet Cong troops. The defoliant worked, but Agent Orange was found to contain an extremely toxic chemical called dioxin, a product of the manufacture of 2,4,5-T. Dioxin was subsequently identified as causing many severe health problems to U.S. service personnel who delivered Agent Orange or otherwise came in contact with it during the war. Many studies link dioxin to cancer.

Because 2,4-D is an organic chlorine compound, many of which are carcinogens, and because human cancers may take twenty or thirty years to develop, the herbicide must continue to be handled sparingly and with the utmost caution.

Sanford S. Singer

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■ JULY 16, 1946

TRUMAN CREATES THE BUREAU OF LAND MANAGEMENT

President Harry S. Truman combined the Taylor Grazing Service with the General Land Office to form the Bureau of Land Management, a resource agency to oversee federal land. The new bureau represented an increase in federal oversight of grazing lands, but it lacked the political clout to remain independent of powerful business interests and became coopted by the very people it was designed to regulate.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Agrarian reform; Animal husbandry; Cattle keeping; Government policy and regulation; Land and land policy

KEY FIGURES

Harry S. Truman (1884-1972), president of the United States, 1945-1953

Frederick William Johnson (1881-1955), director of the Bureau of Land Management, 1946-1948

Patrick Anthony McCarran (1876-1954), U.S. senator from Nevada, 1933-1954

Harold Ickes (1874-1952), U.S. secretary of the interior, 1933-1946

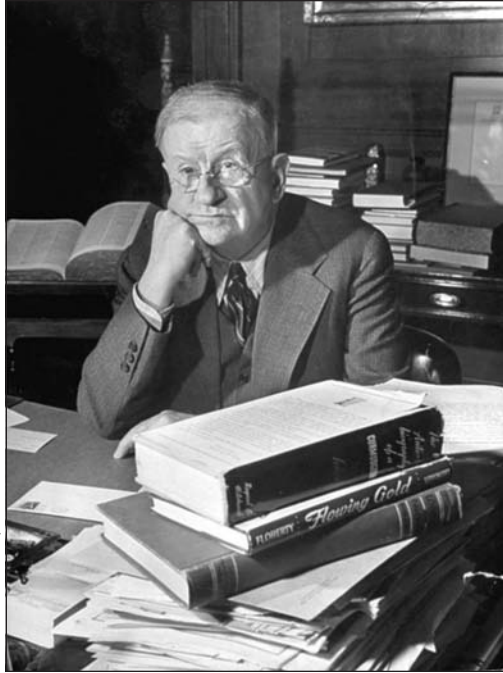
Marion Clawson (1905-1998), director of the Bureau of Land Management, 1948-1953

SUMMARY OF EVENT

In July, 1946, President Harry S. Truman merged the Department of the Interior's General Land Office (GLO) with the financially wounded Taylor Grazing Service to create the Bureau of Land Management (BLM). The Grazing Service had been caught in a bruising struggle between the House Appropriations Committee and U.S. Senator Patrick Anthony McCarran over grazing fees. As a result, its budget and staff were reduced to the point that it could barely operate. Creation of the BLM was the result of the intense rivalry between

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*Secretary of the Interior
Harold Ickes in 1944.*
(George Skadding/
Time Life Pictures/
Getty Images)



the Departments of the Interior and Agriculture during Franklin D. Roosevelt's administration, the power of local grazing advisory boards in rangeland policy, the continuing controversy over grazing fees, and the influence of Senator McCarran.

The rivalry between the Departments of the Interior and Agriculture was intense during the 1930's and 1940's. An expanding National Park Service (which was housed in the Interior Department) was adding to its land base largely by acquiring lands that were once national forests under the administration of the U.S. Forest Service (an agency within the Department of Agriculture). In 1937, a review commissioned by Roosevelt recommended reorganizing the Department of the Interior as a department of conservation that would include the U.S. Forest Service. Interior Secretary Harold Ickes actively sought to expand his department by reacquiring jurisdiction over the national forests, which it had lost in 1905 as a result of the perception that the department's administrators were inefficient and corrupt.

For their part, the U.S. Forest Service and the Department of Agriculture had long sought administrative responsibility for the grazing

districts established under the Taylor Grazing Act (1934). Both agencies had cultivated the political support of the cattle industry and its congressional allies as it became apparent that the Taylor Act would pass.

Ickes's attempt to reacquire the Forest Service brought Gifford Pinchot, a conservation icon and first chief of the Forest Service, into the fray as a vocal opponent, and a noisy controversy followed. The Forest Service sought administration of the grazing districts when the Taylor Act was amended in 1936 but was rebuffed by Congress. The result was a draw. The Forest Service stayed in the Department of Agriculture, no conservation department was created, and the grazing districts stayed under the jurisdiction of the Department of the Interior. However, the infighting occupied the interests of conservationists who paid relatively little heed to the events occurring in local grazing districts.

The Taylor Act had authorized the secretary of the interior to cooperate with cattle industry associations in implementing the law. Farrington Carpenter, the first director of grazing, established a system of grazing advisory boards through administrative action. In fact, establishing grazing permits and regulations would have been impossible without the cattle industry's assistance. In 1939, Senator McCarran introduced amendments to the act that legally established boards composed of five to twelve stockmen and one wildlife representative. Many members of the advisory boards were prominent stockmen, including several leaders of national livestock organizations. Creation of interconnected state and national boards soon followed. The boards grew in power, eventually coming to control local decision making and to heavily influence Grazing Service policy.

In his attempt to woo the stockmen away from the U.S. Forest Service, Ickes had originally asserted that the Department of the Interior could administer the Taylor program for \$150,000 per year and that grazing fees would reflect the costs of program administration. Necessary administrative expenses increased rapidly, and it became apparent that Ickes's estimate was severely low.

Grazing fees for use of federal lands had originated on the national forests in 1906 and would continue to be the subject of much controversy. Shortly after passage of the Taylor Act, Nevada stockmen challenged the right of the secretary of the interior to charge grazing

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fees. A state court upheld their claim, but the decision was reversed in 1941 by the Supreme Court. In 1941, the Grazing Service proposed tripling the fee from five cents per animal unit month (aum), the amount of forage required to feed a one-thousand-pound animal or its equivalent for one month, to fifteen to eighteen cents per aum. The average Forest Service fee at the time was thirty-one cents per aum.

Partly because of strong opposition to the fee in Nevada, McCarran called for an investigation of the Grazing Service in 1940. McCarran was concerned about several issues, including withdrawal of large areas from grazing districts for military reservations, the apparent end of the policy of turning the public domain over to private parties for development, the growth of the administrative costs of the Grazing Service, and the assurance that the federal agency was responsive to local interests. Among other things, McCarran was successful in extracting a promise from the service that there would be no grazing fee increase until his investigation was complete. McCarran's investigation of the Grazing Service continued until 1947 and resulted in greatly increased power of the stockmen over public rangelands.

In 1944 and 1945, the House Appropriations Committee had requested higher grazing fees from the Grazing Service. The director proposed implementing the fifteen- to eighteen-cent fee first suggested in 1941. McCarran blocked the proposal. In the spring of 1946, he gathered support from fellow senators to cut the service's 1947 appropriation for salaries and expenses from \$980,000 to \$550,000. House members were angry that no fee increase had been implemented as requested and agreed to the Senate recommendations. The cut reduced the number of service employees from 250 to 86. The stalemate continued after the BLM was organized, and 1948 appropriations were even smaller.

As the Grazing Service's relations with Congress deteriorated, Ickes recommended merging it with the General Land Office in January, 1946. In May, President Truman forwarded the recommendation to Congress. The House of Representatives opposed the plan, and the Senate, led by McCarran, concurred. The opposition of both houses was required to block the merger. As a result, the Bureau of Land Management came into existence on July 16, 1946.

SIGNIFICANCE

Although creation of the BLM marked the beginning of a new period in the management of the public domain, there was still significant congressional opposition to active federal management of grazing districts. The BLM was not formed by legislative mandate, and many observers believed that its creation illustrated how the conservation of natural resources could be influenced by interest groups that sought to “capture” the agencies responsible for their regulation.

Frederick William Johnson, commissioner of the General Land Office, was named as the bureau’s first director. Johnson proposed to decentralize the cumbersome bureaucracy of the new agency through a set of national, regional, and district offices. The seven proposed regional offices each had jurisdiction over more than one state, making the administrators less subject to local interests and congressional influence. Congress, still angered at the Grazing Service, forbade transfer of functions to regional offices in the 1947 Interior Appropriations Act.

Marion Clawson succeeded Johnson in 1948 and achieved the congressional approval of the regional administrators the same year. Clawson brought the concept of multiple-use management to the bureau and increased the rate of land classification and disposal authorized by the Taylor Act. Grazing fees were increased to twelve cents per aum in 1951, and additional employees were hired to supervise fence-building and water development necessary for better grazing management. Clawson also extended more active management to the bureau’s extensive forestlands in western Oregon and began management of minerals on public lands. With the inauguration of President Dwight D. Eisenhower in 1953, Clawson was perceived as unfriendly to development interests, and he was fired by incoming Secretary of the Interior Douglas McKay.

The last decade of the Grazing Service and the first decade of the BLM illustrate how the agency had been “captured” by the livestock industry. The advisory board system had allowed livestock interests to formulate policy, make rules to implement those policies, and oversee their enforcement. McCarran’s investigation of the Grazing Service, and related hearings in the House of Representatives led by Representative Frank Barrett of Wyoming, fueled the first “sagebrush

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rebellion.” Such congressional action emboldened Western states’-rights advocates and greatly increased the power of stockmen in implementing the Taylor Grazing Act. Sensing their increased political power, the stockmen also pushed for transfer of Forest Service rangelands to the grazing districts and the sale of the federal lands in the districts to the grazing permittees. The last proposal finally raised the ire of conservationists, particularly Bernard De Voto, who devoted several of his “Easy Chair” columns in *Harper’s Magazine* to the subject.

Capture of the Grazing Service and the newly formed BLM was possible because few other organized interest groups were active in rangeland conservation. Wildlife interests had been unenthusiastic about the Taylor Act. Jay N. Darling, a leader of the wildlife interests during the 1930’s, had asked rhetorically, “Where were the 11,000,000 sportsmen and 36,000 groups (of conservationists) when three thousand cattle and sheepmen captured the public domain?” As the number of deer, elk, antelope, and predators on the public lands began to increase during the 1930’s and 1940’s, it became more apparent that livestock and wildlife would compete for the forage resource. By the time of the McCarran and Barrett hearings, it became apparent that postwar interests in recreation and wildlife would prevent the sale of grazing district lands to the livestock industry.

At the time of the Taylor Act and the creation of the Bureau of Land Management, many conservationists were involved in the Interior-Agriculture feud and the protection of national parks and monuments. In many respects, rangelands did not have the aesthetic appeal and popular support available for forests and mountains. The fact that few people outside the livestock industry cared for the rangelands made co-optation of the bureau relatively easy, for no resource-management agency can fare well in the legislative and executive branches without popular political support.

Donald W. Floyd

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■ 1948-1953

SOVIETS TRY TO TRANSFORM NATURE TO IMPROVE AGRICULTURE

The Great Plan for the Transformation of Nature was the world's largest-scale attempt at afforestation in an effort to reduce erosion and permanently change the climate of the Soviet Union for human benefit.

ALSO KNOWN AS: Great Plan for the Transformation of Nature

LOCALE: Soviet Union

AGRICULTURAL ISSUES: Climate change; Collectivization; Drought; Ecology and environment; Famine and hunger; Government policy and regulation; Innovations; Natural disasters; Scientific research

KEY FIGURES

Joseph Stalin (Joseph Vissarionovich Dzhugashvili; 1878-1953), general secretary of the Central Committee of the Communist Party of the Soviet Union, 1922-1953, and premier, 1941-1953

Trofim D. Lysenko (1898-1976), biologist who advocated policies that decreased Soviet agricultural production

V. R. Williams (fl. mid-twentieth century), American soil scientist who influenced Soviet conservation and agricultural policies

SUMMARY OF EVENT

In October, 1948, the Soviet Union, under the leadership of Joseph Stalin, announced the first of several policies that came to be known as Stalin's Great Plan for the Transformation of Nature. The plan had two major elements: the transfer of water that normally flowed to the Arctic Ocean in the north to rivers in the southwestern part of the Soviet Union, and an extensive program of tree planting in the steppe, wooded steppe, and semiarid regions of the Soviet Union to protect the country's vital grain-growing region.

The first element of the program was never implemented. Plans for water transfer from the north to the arid south were vague and included proposals that dated back to the nineteenth century. Some of

the proposals were given significant consideration, but high costs and difficult engineering resulted in the postponement of the major interbasin transfer schemes.

Nevertheless, the key part of the program, articulated in an October, 1948, speech by Stalin, was vigorously pursued until Stalin's death in 1953. An extensive afforestation and shelterbelt project was developed that would take up to fifteen years to complete and cover portions of eight Soviet states in the southwestern Soviet Union. Under the plan, collective and state farms would plant shelterbelts, long rows of trees up to one hundred feet wide, on approximately 15 million acres of land, protecting an additional 300 million acres of farmland. Soviet scientists and policy makers believed that the shelterbelts would shield farmland from winds that dried out the land and blew away the topsoil. There was also an underlying belief that planting a large number of trees would cause an increase in rainfall. (There is, in fact, almost no scientific evidence that shelterbelt planting significantly increases a region's rainfall.)

Stalin and the Soviet planners attempted this costly and unpromising program to address problems inherent in the overall geography of the Soviet Union. In part, they were responding to a history of drought and other catastrophes that had long affected Soviet agricultural productivity. The enshrinement of science as an ideology with creative powers, the conviction that climate could be changed, and the committed and forceful role of Stalin were factors in the implementation of the great plan.

The Soviet Union faced major agricultural problems because of its physical geography. The bulk of the region is too northern in latitude or too continental in location to have temperatures consistent with high agricultural output. Furthermore, soils in many parts of the region are of poor quality. The exception are portions of the Russian steppe, which is located in the post-Soviet countries of Russia, Ukraine, and Kazakhstan. In these areas, soils are of high fertility. Unfortunately, however, rainfall in this region frequently falls short of what is needed to obtain consistent grain yields. This situation periodically contributes to grain shortfalls.

During the first half of the twentieth century, drought haunted the Soviet grain-producing regions. Particularly severe droughts devastated the steppe landscape in 1946 and 1948. Wind erosion in the

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steppe zone created extensive dust storms. The droughts and wind convinced Stalin that only the planting of trees could transform the region's climate and increase agricultural yields.

Stalin and his planners blamed low agricultural yields on the country's inhospitable environment. There were other, human-made, catastrophes that ravaged the country's farms, however. Many of these were created by the government itself. Stalin and the government began the process of collectivizing agriculture during the 1920's and 1930's. Rather than give up their farms, many peasants burned their fields, killed their livestock, and revolted. Millions of peasants were run off their farms, killed, or forced to work on enormous collective farms. Many researchers suggest that this, more than any other factor, impeded Soviet agriculture. World War II also destroyed much of the country's productive capacity. In 1917, the Communists imposed a new standard on scientists that gave them creative powers. Communist officials hoped that science could be used to transform the underdeveloped, agriculturally based Russian empire into an advanced industrial-agricultural nation. A new



Russian women working on a collective farm while many Russian men were fighting in World War II. (Library of Congress)

Soviet scientific ideology was formed within the broader framework of communism. Politicians and scientists stressed the need to overcome the physical limitations of the harsh Russian environment.

Several scientists with strong political connections advocated this new ideology of transforming nature. Trofim D. Lysenko and V. R. Williams became important figures in the development of a new pseudoscientific ideology, and these two men virtually dictated the government's official agricultural science program. Williams's controversial theories on grassland agriculture and Lysenko's poorly documented theories were indirectly incorporated into Stalin's Great Plan for the Transformation of Nature. "Lysenkoism," as it came to be known, was not completely purged from Soviet scientific circles until the 1970's. This investiture of science with creative powers to serve Communist needs resulted in unobjective, often dubious research that ultimately hindered the Soviet economy.

Communist scientists thus provided the research that convinced Stalin and government planners that nature could be permanently transformed. Dozens of pre-1948 research studies suggested that, at the very least, the microclimate (the climate in the area around the fields) could be altered by large-scale shelterbelt planting. Implicit in some of these reports, and in the minds of Stalin and many politicians, was the belief that shelterbelts could result in wholesale climate change in the steppe zone.

Stalin's personality and power were significant in the implementation of the Great Plan for the Transformation of Nature. Stalin and his cohorts provided the dogma, motivation, and assurance required for activation of the plan. Stalin's forceful and ruthless manner was seldom questioned. Perhaps the best testament to Stalin's importance to the plan's adoption is that the plan was largely abandoned after his death in 1953.

The water-transfer portion of Stalin's plan was never implemented, but the shelterbelt portion was partially completed. The afforestation part of the plan aimed to plant trees on 10.4 million acres of *kolkhoz* (collective farm) land, of which 9 million acres would be planted by the farmers at their own expense. The government would plant 1.4 million acres on the farms. By 1955, more than 12 million acres were to have been in shelterbelts.

At the close of 1949, trees had been planted on 1.2 million acres, considerably more than expected. It seemed that the periodic crop failures of the past would become only a dim memory. While the 1949 harvest was below average, excitement for the afforestation project intensified, and the press was forbidden to publish any critical reports on the project. In 1950 and 1951, however, the planting targets fell behind schedule. By 1951, it appeared that nearly 50 percent of all trees planted in 1949 had died. As the peasants became overworked, the rate of planting started to decline. Trees were left untended. Inadequate watering practices and inappropriate planting stock contributed to the collapse of Stalin's plan. The semiarid climate caused the failure of many shelterbelts.

After Stalin's death in 1953, the shelterbelt program was discontinued. The state committee in charge of tree-planting was dismissed, and statistics regarding the program were unavailable after 1958. Many shelterbelts were left unattended or incomplete. It has been estimated that 10 percent of the trees planted during Stalin's Great Plan for the Transformation of Nature survived.

SIGNIFICANCE

Stalin's Great Plan for the Transformation of Nature was essentially an attempt to achieve long-term sustainability in the grain-growing region of the Soviet Union. In the minds of Stalin and his cohorts, sustainability meant that the Soviet environment would be changed to meet the long-term needs of Soviet agriculture. Since Soviet science was credited with creative powers, Stalin and his associates believed that this long-term sustainability could be accomplished quickly, solving the immediate problem of low yields and the more persistent challenges of a semiarid environment. The plan was not a success; however, it did have short-term impacts and long-term implications for Soviet agricultural policy.

Some areas did receive protection from the shelterbelts. Estimates vary, but approximately 1.2 million acres of the 15 million planned acres survived. These were generally in the wooded steppe zone and in moister portions of the region, such as in Ukraine. The drier semi-desert zones of the Russian steppe, such as in Kazakhstan, which could have profited most from the shelterbelts, were unable to sustain afforestation efforts. Even if the entire plan had been carried



Soviet postage stamp from 1954 encouraging farmers to grow larger vegetables. (Arkent Archive)

out, it is highly unlikely that the climate of the region would have been significantly altered. Large-scale water transfers from rivers flowing to the Arctic probably would have created a host of other environmental problems. This has been evidenced by intraregional water projects on the Volga and other rivers, projects that have resulted in severe and costly impacts on the rivers themselves, on the Caspian Sea, and on the Aral Sea.

In the long term, Stalin's plan contributed to similar types of programs aimed at altering the environment for human benefit. While the shelterbelt portion of the program officially ended with Stalin's death, interest in shelterbelts and afforestation continued. Since the 1950's, dozens of Soviet research reports have been published on the microclimatic impacts of shelterbelts on soil temperature and evaporation, water budgets near the trees, and wind speed. These studies seldom claim that shelterbelts and forests have large-scale regional climatic impacts, but rather that they produce a mix of beneficial and detrimental influences on nearby fields.

Later attempts at shelterbelt planting were proposed under circumstances similar to Stalin's plan, mainly after periods of drought or low agricultural yields. During the late 1960's, Soviet premier Leonid Brezhnev called for plans that included the planting of shelterbelts on 800,000 acres of gullies and sandy lands.

From its birth, the Soviet government had an affinity for ambitious projects. Stalin's plan represented one of many. After Stalin's death, his successor Nikita S. Khrushchev implemented the Virgin and Idle Lands Program, which brought more than 90 million acres of land into production between 1954 and 1960. Most of the land was in areas of marginal rainfall in the southwestern and southern Soviet Union. While the large-scale Arctic-to-south water transfers have largely failed to materialize, the Soviet government did implement dozens of other water projects in the south, especially along the Volga and the rivers feeding the Aral Sea. Detailed research continues to be performed on major interbasin water transfer schemes.

The breakup of the Soviet Union has imposed economic constraints on the pursuit of similar projects. In the long term, however, the need for increased agricultural production may foster a renewed interest in projects that promise quick solutions to enduring geographic and climatic problems.

David M. Diggs

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■ JANUARY, 1953

FIVE-YEAR PLAN BEGINS CHINA'S AGRICULTURAL COLLECTIVIZATION

By implementing the First Five-Year Plan, the new People's Republic of China moved decisively toward centrally planned, large-scale national economic development.

ALSO KNOWN AS: First Five-Year Plan of the People's Republic of China for Developing the National Economy

LOCALE: People's Republic of China

AGRICULTURAL ISSUES: Collectivization; Famine and hunger; Flooding; Government policy and regulation; Natural disasters; Population growth

KEY FIGURES

Mao Zedong (Mao Tse-tung; 1893-1976), chairman of the Chinese Communist Party, 1935-1976, and top Chinese leader, 1949-1976
Zhou Enlai (Chou En-lai; 1898-1976), chief foreign minister of the Chinese Communist Party, 1935-1976, and premier of China, 1949-1976

Liu Shaoqi (Liu Shao-ch'i; 1898-1969), president of the People's Republic of China, 1959-1968

Deng Xiaoping (Teng Hsiao-p'ing; 1904-1997), general secretary of the Chinese Communist Party, 1956-1967, and later de facto leader of China

Chen Yun (1905-1995), Chinese economic planner

Peng Dehuai (P'eng Te-huai; 1898-1974), Chinese military leader

SUMMARY OF EVENT

The implementation of China's First Five-Year Plan was the beginning of the country's centrally planned economic development and industrialization. From 1953 to 1957, production more than doubled; numerous factories, roads, and dams were built. By 1957, 97 percent of land was collectivized, or put under state control. The Great Leap Forward in 1958 attempted to decentralize the economic

management system. The Great Leap Forward ended in January, 1961, after poor harvests in 1959 and 1960 and termination of Soviet technical aid in 1960.

The People's Republic of China was established in October, 1949. Its first three years were a period of rehabilitation. By 1952, the gross value of industrial output had grown to two and a half times that of 1949 and exceeded prewar levels by almost 25 percent. Agricultural output also exceeded prewar levels.

In late 1952, Chinese leaders decided to undertake long-term economic development. Because of lack of experience in both economic planning and advanced technology, Chinese leaders had to rely heavily on foreign aid for their economic development. At that time, the Soviet Union was the only country willing and able to provide China with economic and technical assistance. With little alternative, Chinese leaders adopted the Soviet model for China's economic development.

The First Five-Year Plan started in January, 1953, although final details were not agreed upon, and the plan was not published until July, 1955. The most important proposal in the plan was to raise to about 20 percent the share of the nation's resources to be invested, and to use these resources for the development of heavy industry. The acquisition of investment resources was to be achieved by imposing compulsory purchases and taxes on agriculture and private industry and by earning high profits in state-owned industries. The controlled allocation of resources was to be accomplished through a Soviet-style apparatus for the central planning of state industry and wholesale, retail, and foreign trade. Control of foreign trade was particularly crucial, since the strategy adopted required that China sell agricultural products to pay for industrial goods and materials supplied by the Soviet Union. It is important to note that the plan did not call for immediate nationalization of private industry and commerce.

Planning was adopted gradually in China. The State Statistical Bureau was set up on October, 1952. The chief organ of planning, the State Planning Commission, was established in 1952 and was placed under the State Council when the latter was made the supreme executive body by the 1954 constitution. At the same time, a State Construction Commission was organized to oversee capital investment under the First Five-Year Plan, which covered the 1953-1957 period.

The complete title of the plan is the First Five-Year Plan of the People's Republic of China for Developing the National Economy.

The method of central planning adopted, based on Soviet experience, was that of "material balances," sometimes referred to as input-output analysis. Tables are prepared to indicate, based on experience and expectations, how the output of each industry or sector of the economy is distributed among all producing industries or sectors, plus final demand. With such a table of intersectoral balances, it is then possible to project the pattern of demand for each sector's output that will be generated by a given planned rate and pattern of growth and to compare it with the supplies likely to be made available by existing capacities and their planned expansions. If balance between anticipated supply and demand is lacking, the plan is adjusted and the possibility of using foreign trade to fill the gaps is explored.

The fundamental task of the plan was to implement 156 development construction projects that were designed with Soviet assistance. During this period, 145 construction projects were to be started or completed. Eleven others were scheduled to start during the period of the Second Five-Year Plan (1958-1962).

Until November, 1957, China's planning system was highly centralized, in the sense that a fairly large number of targets of different kinds were drawn up and their fulfillment directly supervised by the central government. These targets applied to an originally small but rapidly growing number of goods. As both the number of commodities and the number of enterprises for which the center assumed responsibility grew rapidly in the course of the 1950's, the maintenance of such a high degree of centralization of both planning and management became increasingly cumbersome. In 1957 and 1958, the government adopted a series of decentralization measures in order to delegate some of its responsibilities to the localities, increase the scope for local initiative, and strengthen central control of the most important plan targets and enterprises.

Total planned investment by the state for the five-year period came to 76.640 billion yuan (\$32.154 billion at the official exchange rate of 2.46 yuan to the U.S. dollar). Some three-fifths of state investment was to be devoted to capital construction. About three-fifths of that was earmarked for industry, most of it for heavy industry, fuel production, and machine building. Agricultural investment was to be limited to a

little more than 1 billion yuan, or 2.4 percent of planned capital construction. The Chinese leadership was always acutely aware of the need for agricultural surpluses as a condition for rapid industrialization.

Impatient with the gradual pace of collectivization set by the First Five-Year Plan, Mao Zedong called for an immediate acceleration of agricultural collectivization. Mao's impact on agricultural collectivization was dramatic. By March, 1956, more than 90 percent of Chinese peasants were living and working in cooperatives, and by 1957 virtually all were in the higher-stage cooperatives. Thus an agricultural collectivization anticipated to take fifteen years according to the First Five-Year Plan was completed in little more than one year. The results, however, were unsatisfactory. Mao's expectation that changes in ownership and organization would produce immediate economic effects was belied by events. By the fall of 1957, it was apparent that the growth of agriculture was still too slow, that urban unemployment was a serious problem, and that relations with the Soviet Union, on which industrial assistance depended, were worsening. This crisis led Mao to launch the most extraordinary economic adventure that the world has ever seen, the Great Leap Forward of 1958.

SIGNIFICANCE

The First Five-Year Plan scored major successes in laying the foundations for industrialization strategy in China. The First Five-Year Plan achieved a dramatic increase in industrial production across a broad sector of goods. Most of the plan targets had already been fulfilled by the end of 1956. Political and economic difficulties arising out of the First Five-Year Plan, however, had serious consequences. First, there was inadequate growth of agricultural production and procurement. Grain outlet stagnated. Second, planning and administration, in their highly centralized form, had become increasingly ineffective as the economy grew in size and complexity, and especially after most industry and commerce came under direct state control in 1956. Third, the industrialization strategy of the First Five-Year Plan had proved incapable of solving the unemployment problem.

From 1953 to 1957, China's population grew from 582.6 million to 646.5 million. According to official statistics, industrial production grew during those five years at an annual rate of 18 percent, while agricultural production rose 4.5 percent a year and the output of food

grains by 3.7 percent, barely surpassing the population's growth rate. Bottlenecks in the production of raw materials forced planners to reconsider the development plan.

In general, economic performance was quite good during the period of the First Five-Year Plan, even though the growth was unbalanced between industry and agriculture. The average annual growth rate of national income reached 8.9 percent. The high level of investment spending in industry resulted in a high rate of industrial growth. Within the industrial sector, the annual growth rate of steel output in terms of quantity was 31.8 percent. Chemical fertilizer production increased by 29.3 percent annually, and electric power by 20.4 percent. The annual increase rate of grain production, in contrast, was only 4 percent, and production of cotton increased by 4.7 percent annually.

The First Five-Year Plan had a number of drawbacks. First, the plan required large forced savings from the agricultural sector. Second, the plan placed undue concentration of investment in such heavy industries as steel at the expense not only of agriculture but also of light and consumer goods industries. Third, the plan required a high degree of centralization and the development of an elaborate bureaucratic structure to implement, control, and check the plan according to fixed targets and quotas.

In establishing urban industries, setting up management systems, embarking on long-term planning, and providing for scientific and technical education, the Chinese during the early 1950's had only the Soviet Union to turn to for models, assistance, and advice. The Soviet Union was willing to provide assistance in the form of plants, machinery, and systems of organization and management, which inevitably resembled their counterparts at home.

In the latter stages of the First Five-Year Plan, hundreds of thousands of peasants were mobilized to build roads and dredge canals. The Great Leap Forward began in March, 1958, when some sixty million peasants were assigned to build and operate millions of factories and backyard furnaces.

The first people's commune was organized in April, 1958. In August, the Chinese Communist Party adopted a resolution on the establishment of people's communes in rural areas. Following its provisions, cooperatives everywhere were merged immediately into communes. By the end of September, 1958, there was 26,425 com-

munes in the rural areas, representing 98.2 percent of the total number of peasant households. The commune was a much larger and more advanced form of collectivization than the cooperative. The people's commune was the basic social structure combining industry, agriculture, trade, education, and the military.

As the Great Leap Forward went on into 1959, administrative confusion deepened, and the consequences of strain, of the misuse of resources, and of sheer human exhaustion became increasingly serious. When the end came, it coincided with the withdrawal of Soviet assistance and a succession of natural disasters. The results were appalling.

Soviet aid to China was in the form of interest-bearing loans, not grants. Some Chinese leaders were not satisfied with the prices the Soviets set for their equipment and plants or with the interest rate charged for loans. China had to repay these loans with its products, gold, and foreign currencies. Investments thus had to pay off quickly, and at rates above the rate of interest charged by the Soviets, if investment was not to be a drain on the Chinese economy.

Mao spelled out his strategies for achieving the objective of the Great Leap Forward in two simple slogans: "walking on two legs" and the "five dualities." Walking on two legs meant that growth should be balanced between industry and agriculture. The five dualities were to develop industry and agriculture simultaneously, to develop light industry and heavy industry simultaneously, to develop large enterprises simultaneously with medium-sized and small enterprises, to develop state industry and local industry simultaneously, and to use traditional production technology and modern production technology simultaneously.

In 1958, 700,000 small blast furnaces were built to produce steel, and 100,000 small coal pits were set up. These blast furnaces and coal pits were staffed by inexperienced workers who used old production processes. Mao knew that building modern steel mills would take several years and huge amounts of capital investment. He attempted to substitute labor for capital by using outdated technology.

During the Great Leap Forward, some statistics on increased production were based on exaggeration and fabrication. Millions of tons of pig iron, much substandard and all a long way from being steel, were produced by backyard furnaces. The pig iron accumulated along railways that could not possibly handle its movement, causing

serious bottlenecks in the transport system. In 1958, when the Great Leap Forward and commune programs were launched, there was a good harvest. In 1959, heavy floods and drought laid waste to almost half of the cultivable land. Then, in 1960, floods, drought, and pests ravaged millions of acres. To make matters worse, the Soviets withdrew all of their technicians and advisers from China in June, 1960, because of disagreements concerning development strategy. The drastic reduction in agricultural production stalled the drive for rapid development of industry.

The Great Leap Forward ended in failure because the program merely promoted “excessive targets,” with cadres issuing arbitrary decisions. The Great Leap Forward was not carefully planned and was rashly implemented, causing a huge waste of both material and human resources. The estimated loss during the years of the Great Leap Forward, 1958-1960, amounted to \$66 billion.

The chaotic situation in China's economy was exacerbated by the unexpected withdrawal in August, 1960, of all Soviet economists and technicians working in China. China learned a bitter lesson from the surprise Soviet withdrawal. Facing growing criticism from both domestic and foreign sources, Mao resigned from the presidency of the People's Republic of China and gave the position to Liu Shaoqi. During the early 1960's, China's economy entered a period of recovery and consolidation. The relatively peaceful development of China's economy was once again disrupted by the Cultural Revolution of 1966.

Guoli Liu

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■ JUNE 18-27, 1954

UNITED FRUIT COMPANY INSTIGATES A COUP IN GUATEMALA

Owners of the United Fruit Company forestalled agrarian reform in Guatemala by using the Central Intelligence Agency of the United States to overthrow the legitimate government of Jacobo Arbenz Guzmán.

ALSO KNOWN AS: Operation PBSUCCESS

LOCALE: Guatemala City, Guatemala

AGRICULTURAL ISSUES: Agrarian reform; Marketing and trade; Tropical produce

KEY FIGURES

Jacobo Arbenz Guzmán (1913-1971), president of Guatemala, 1951-1954

Henry Cabot Lodge, Jr. (1902-1985), U.S. senator from Massachusetts, 1937-1944 and 1947-1953, and delegate to the United Nations, 1953-1960

Allen Dulles (1893-1969), U.S. director of central intelligence, 1953-1961

John Foster Dulles (1888-1959), U.S. secretary of state, 1953-1959

Jorge Ubico Casteñeda (1878-1946), president of Guatemala, 1931-1944

Juan José Arévalo Bermejo (1904-1990), president of Guatemala, 1945-1951

Carlos Castillo Armas (1914-1957), president of Guatemala, 1954-1957

SUMMARY OF EVENT

Ownership of land in Guatemala is among the least equitably distributed in the Western world. The vast proportion of foreign-owned holdings not in cultivation has always tempted reformers. As a principal landholder in Central America, the United Fruit Company (UFCO) was particularly vulnerable to pressures for land reform.

The regime of President Jorge Ubico Casteñeda was supported by the landed aristocracy and foreign-owned agribusinesses, which Ubico allowed to operate with almost complete autonomy and with-

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out taxation. When it was expedient, Ubico reduced the daily minimum wage to be paid to field hands and had leaders of reform movements executed. To maintain stability, under these social pressures, in the region surrounding the Panama Canal, the United States government contributed generously to Guatemala's military establishment.

Following this repressive, almost feudal reign that ended with Ubico's forced resignation in 1944, the governments of Juan José Arévalo Bermejo and Jacobo Arbenz Guzmán seemed socially visionary. Arévalo introduced a social security program, expanded rural education, and instituted open elections. He encouraged co-operatives to aid the peasants whose ownership of tiny parcels of land maintained them in poverty and dependence on foreign employers in a country that showed, by its exports, that it could be self-sustaining.

Pressure for social reform led inevitably to rising feeling against foreign-owned corporations such as UFCO and its subsidiary, the International Railway of Central America. The railway became particularly vulnerable when Arbenz proposed a highway to compete with it. Loss of the transport monopoly for its crops would directly affect United Fruit as well as other agricultural firms.

On June 27, 1952, Arbenz introduced Decree 900, an agricultural land reform act that expropriated farms that had more than 223 acres not in cultivation. Expropriated land was to be distributed to land-poor peasants in plots of 42.5 acres. This was to enable them to sustain their families without being required to work for UFCO or other large landowners for low wages. All expropriated land was to be paid for with government bonds. During the eighteen-month program, 100,000 families received plots. About 1.5 million acres were distributed, for which the owners were paid more than \$8 million.

The United Fruit Company had been allowed to claim a very low taxable value for its land to reduce its tax liability, and it was this taxable worth that was used to set the payments for expropriated land. The company thought this to be inequitable and asked the U.S. State Department to intervene. The State Department demanded millions of dollars more, asking for \$75 an acre. The government of Guatemala had set the price at \$2.99 an acre. Because the land in dispute had been acquired by UFCO only twenty years earlier for \$1.48 an

THE RISE OF “BANANA REPUBLICS”

Bananas were introduced to the U.S. public by late nineteenth century shipowners, who included small amounts of the fruit as supplements to their regular shipments. Bananas proved to be so popular that some U.S. entrepreneurs decided to expand the trade. Banana cultivation at that time was limited to the small output of a few Caribbean islands, hardly adequate for the presumed demand that existed in the United States. The investors decided to establish banana plantations elsewhere on a much grander scale.

The east coast of the Central American isthmus offered an ideal location for the establishment of extensive banana cultivation, providing a broad geographical production base that could weather the frequent storms that plagued the Caribbean. Central American governments involved eagerly sought potential investors in the largely undeveloped lowlands. Railroad builders in the area saw business opportunities in the development of the new agricultural industry. Soon, swamps were drained, modern harbor facilities built, and large tracts of land put into cultivation. The banana industry provided jobs for native labor and furnished health and educational facilities for their employees.

The banana business became so large and profitable that the major U.S. companies, such as United Fruit and Standard Fruit, could virtually dictate policy to the local Central American governments. Throughout the early twentieth century, the fruit companies dominated the economies of Honduras, Costa Rica, Panama, and, to a lesser extent, Guatemala. After World



(Library of Congress)

War II, however, as both the governments and the economies of these countries grew more sophisticated, the economic and political power of the fruit companies diminished. Moreover, the U.S. government ceased to support the claims of private companies to the same degree that it did in the nineteenth and early twentieth centuries.

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acre, Guillermo Toriello, the foreign minister of Guatemala, coldly refused the State Department request.

While the governments of the two nations argued this question, the United States saw other disturbing developments in Guatemala. Many exiled communists, particularly from Peru and Chile, lived in Central and South America at the time. When Arbenz formed agencies to manage his agrarian reforms, he selected some of the educated and willing workers he needed from among these communist émigrés. He resisted pressure from the United States to purge them from his government, saying that Guatemala was a country where all views were welcome.

In May, 1954, a shipment of weapons from Czechoslovakia arrived in Puerto Barrios, Guatemala, ostensibly to replenish the armories of the Guatemalan military, which had been barred from buying arms from the United States since 1948 as a result of a treaty disagreement. This shipment alarmed many in the United States, who saw it as part of a communist plot to infiltrate Central America.

In the United States, the fear of encroaching communism was having a profound effect on internal policy. Senator Joseph McCarthy had elevated himself to prominence by alerting Americans to real and imagined communist plots in every profession, most notably Hollywood film production. He also suggested communist influence in the Central Intelligence Agency (CIA). Whether there was any communist threat in the CIA is unimportant. The agency thought that a demonstration of its loyalty was desirable to disarm suspicions.

Owners of UFCO included several who occupied positions of prominence in the United States government and the United Nations. The Lodge family was heavily invested, as were the Dulles brothers—Allen, director of the CIA, and John Foster, the secretary of state. When further expropriations of idle land owned by UFCO were made, the CIA was directed to plan and execute a clandestine operation to effect a coup in Guatemala. This action, called “Operation PBSUCCESS,” was intended to protect the holdings of United States corporations and discourage further growth of communist influence in Central America.

On June 18, 1954, Guatemala was invaded by rebels from across the border in Honduras following aerial harassment of the capital and the port of San Jose by aircraft owned by the United States and by

the United Fruit Company. The capital was defended in desultory fashion by six obsolete warplanes of American manufacture.

When the assault began, Ambassador Henry Cabot Lodge, Jr., the United States' delegate to the United Nations Security Council, was president of the council. He introduced a motion to transfer consideration of the Guatemalan "affair" from that international arena to the Organization of American States, which was dominated politically by the United States. He argued that the Guatemalan situation constituted a civil war. The Soviet Union vetoed the motion, representing the affair as an American effort to stifle a commercially uncooperative government.

France introduced a resolution ordering a truce and restraining Security Council members from further participation in the conflict. That action soothed the fears of the nations surrounding Guatemala but had no effect on the actual conflict. On June 27, 1954, Arbenz went on Guatemalan radio and surrendered. Many of his countrymen missed the broadcast, which was jammed by the CIA.

Carlos Castillo Armas replaced Arbenz as president of Guatemala. In a short while, the expropriated lands were returned to the foreign corporations, and labor unions were disbanded. There was widespread bloodshed as workers sought in vain to retain the real and potential reforms gained during the Arévalos and Arbenz regimes. A military response, supported by assistance from the United States, was necessary to restore order. The military continued for decades to sustain the conservative government of Guatemala and offer protection to foreign investments there.

SIGNIFICANCE

Operation PBSUCCESS had three primary effects on the economy of the Western Hemisphere. First, the two desired outcomes of the coup—restoration of UFCO property and rejection of communist influence in Guatemala—were secured. The pre-Arbenz system of agricultural management was restored to the United Fruit Company and its sister corporations. In an agreement negotiated with President Armas himself, UFCO recovered all of its expropriated lands, and a new, modest income tax plan was negotiated to the company's benefit.

A second effect on the Guatemalan economy was caused by Presi-

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dent Armas's action to cancel the registration of 533 union locals advocating the rights of banana workers as well as other unions not associated with UFCO directly but having an economic relationship, such as the railway workers. Active union organizers on UFCO farms were assassinated. Organized reaction against the new economic policies was thus effectively prevented until the rise of outlaw guerrilla groups.

The third important effect of the coup on the Guatemalan economy was the growth of a strong and lasting enmity to the new regime and to the United States' involvement in its emergence. The new government became synonymous in people's minds with the *frutera*, as UFCO was called in Latin America. Modern movements advocating human rights and social reform largely bypassed Guatemala, lest they also be painted by the United States as "communist" and similarly attacked.

As a consequence of these changes, the social and economic situation in Guatemala returned to what it had been in the first half of the twentieth century. Land ownership, skewed heavily in favor of a few large landowners before Arbenz's Decree 900, was again so skewed. Most small landowners were unable to support their families on the parcels available to them, many on infertile mountainsides.

To earn the sustenance their families required, these small landholders worked on the plantations. Lacking other lodging in the lowlands, many moved their families temporarily directly onto the fields they worked. There they were vulnerable to the health effects of chemicals that, in the absence of modern ecological controls, were generously applied.

Guerrillas intent on maintaining instability engaged in ongoing efforts to cripple the activity of the large foreign companies and to discourage new investment. Domestic and foreign firms increasingly sheltered their capital by moving it out of Guatemala. The necessities of life, such as fuel and food, increasingly had to be imported, driving Guatemala's economy downward and its debts to others upward.

One lasting effect of the reversal of the reform movement by Operation PBSUCCESS was a greater availability of labor in the cities, as rural people fled the oppressive conditions and starvation wages of the plantations. Unfortunately, the instability of the country's government discouraged investment to utilize this resource.

The political climate of Guatemala following Operation PBSUCCESS made it impossible to establish a large tax base in the regions actually producing the profits for the foreign owners. Without tax revenues consistent with the value of the land and its products, governmental investment in social, educational, and developmental programs was severely limited.

These severe conditions on the farms resulted in the same migration to the cities found elsewhere in Latin America. Unfortunately, the unsettling factors caused by the militantly conservative government prevented evolution of social programs and infrastructure necessary to keep pace with this influx. Poverty and substandard living conditions plagued cities as well as farms.

Growth of the economy, which was near 5 percent in the years immediately after the coup, ceased. External debt, which was \$51 million in 1960, rose into the billions of dollars. Foreign aid declined sharply as the nations of Europe and North America experienced tightening in their own economies. Improvement in the social or economic lot of the people of Guatemala seemed unlikely until something akin to the reforms of 1944-1954 recurred.

Loring Emery

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■ JULY 10, 1954

FOOD FOR PEACE PROGRAM SENDS AGRICULTURAL SURPLUS ABROAD

President Dwight D. Eisenhower signed Public Law 480, allowing the U.S. Department of Agriculture to buy surplus agricultural commodities and use them for donation abroad, for barter, or for sale for foreign currencies.

ALSO KNOWN AS: Public Law 480, 83d Congress; Agricultural Trade Development and Assistance Act of 1954

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Government policy and regulation; International food relief; Marketing and trade; Price supports and controls

KEY FIGURES

Dwight D. Eisenhower (1890-1969), president of the United States, 1953-1961

Ezra Taft Benson (1899-1994), U.S. secretary of agriculture, 1953-1961

Don Paarlberg (1911-2006), U.S. assistant secretary of agriculture

Clarence Francis (1888-1985), special adviser to President Eisenhower on the disposal of agricultural surpluses

Clarence Randall (1891-1967), special assistant to President Eisenhower on foreign economic policy

William S. Hill (1886-1972), U.S. representative from Colorado, 1941-1959

SUMMARY OF EVENT

The Agricultural Trade Development and Assistance Act of 1954, commonly known as Public Law 480 or the “Food for Peace” program, provides for surplus U.S. farm commodities to be sold for foreign currencies and used as donations and barter goods. The objectives of PL 480, as stated by Congress, are to promote economic stability for American agriculture, to expand international trade in agricultural commodities, to encourage the economic development of friendly countries, and to promote the collective strength of the free world.

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A variety of factors led to the passage of this legislation. Food and peace have long been closely linked in the minds of Americans. Many times in the aftermath of war, food from U.S. farms has aided in the rehabilitation of ravaged areas. In addition, from a political standpoint food has often been used as a lever to achieve political goals and objectives.

During the 1940's and 1950's, a domestic agricultural problem developed. Incomes from food production in the United States did not permit American farmers to live on a scale comparable to that of people in other occupations. In order to boost farm incomes, the government agreed to buy certain products that could not be sold on the open market above a specified price. Between February, 1952, and February, 1956, the stocks of the Commodity Credit Corporation (CCC, the governmental agency charged with stockpiling surplus agricultural goods) in inventory as well as pledged against outstanding loans and purchase agreements increased almost fivefold, from less than \$2 billion to \$9.1 billion.

Most of this buildup took place during 1952 and 1953, when annual increases in the stockpiles of 70 and 100 percent were registered. This problem of surplus government stocks was exacerbated by scientific technology. Farm productivity during this same period had increased significantly as a result of better products to control weeds, plant diseases, insects, and parasites, combined with developments in plant and livestock genetics and improved farm machinery.

An additional factor was important in the subsequent passage of PL 480. American farm exports had been declining during the early 1950's. Factors in this decline included a reduction in American economic aid to Western Europe (which had been quite high under the Marshall Plan following World War II), the fact that agricultural production and protectionism were recovering in Western Europe, scarcity of the dollar in importing countries, domestic price supports that set American commodity prices above world levels, and American export controls that limited trade with the Soviet Union and its allies. As the repercussions of the decline in exports and the growth of surplus stocks rolled across the farm economy, farm spokespeople began demanding that the government act to stabilize farm income. President Dwight D. Eisenhower's administration was faced with the task of dealing with these multiple problems.

Food for Peace Program Sends Agricultural Surplus Abroad

In the summer and fall of 1953, three groups began wrestling with program proposals for agricultural policy: the U.S. Department of Agriculture, the Commission on Foreign Economic Policy, and an interdepartmental committee on the surplus. In the summer of 1953, the U.S. Department of Agriculture surveyed three national farm groups—the American Farm Bureau, the Grange, and the National Farmers Union—regarding farm income stability and trade versus aid, among other things. Overwhelming support was shown for a “two-price” plan for agricultural commodities. Such a scheme would support a high domestic price for the percentage of a commodity normally marketed in the United States and would allow the remainder (ostensibly exported) to be sold at the world price. Thus, the mood in the country was to continue farm income support.

The Commission on Foreign Economic Policy was chaired by Clarence Randall, special assistant to President Eisenhower on foreign economic policy. The seventeen-member group was composed of agribusiness representatives, prominent agricultural economists, five U.S. senators, and five U.S. representatives. Agricultural policy was only part of the foreign economic policy reviewed by the commission. The commission issued a report on January 23, 1954, that included a five-page section on agricultural policy. The section on agriculture elicited written dissents from eight of the seventeen members. The report argued that “a dynamic foreign economic pol-



President Dwight D. Eisenhower.
(National Archives)

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icy as it relates to agriculture cannot be built out of a maze of restrictive devices such as inflexible price-support programs which result in fixed prices, open or concealed export subsidies, . . . and state trading." It recommended the complete "elimination of such devices as a part of, or supplement to, our own agricultural policy."

This obviously went against the wishes of American farmers. The Department of Agriculture was effective in nullifying the report's agricultural recommendations by insisting that any inconsistencies between the report and President Eisenhower's January state of the union message be resolved in favor of the latter, in which Eisenhower had supported price supports on farm commodities.

Meanwhile, the interdepartmental committee on the surplus had been working on legislation. This study group had been Secretary of Agriculture Ezra Taft Benson's idea. He had persuaded President Eisenhower to establish it at the subcabinet level. After several meetings, on December 14, 1953, this committee had in hand the first draft of an administration surplus disposal bill. Despite President Eisenhower's call for fast action, the committee could not agree on a final draft bill. Stumbling blocks included disputes concerning which commodities to include, who would have administrative authority, and to what extent the private sector should be involved.

While the administration squabbled, the House of Representatives began considering various surplus disposal bills. As the spring of 1954 wore on, some sixty bills were introduced into Congress. This flurry of activity spurred the interdepartmental committee to compromise. A compromise draft was introduced by Representative William S. Hill of Colorado. It was discussed by the House Committee on Agriculture on June 3, reported out, debated for two days by the House as a Committee of the Whole, and passed on June 16. Following rapid Senate action, the conference committee made some adjustments. The bill was agreed to by both houses, and Eisenhower signed it into law on July 10.

SIGNIFICANCE

As passed, Public Law 480 had three titles. Title I authorized sales of surplus agricultural commodities for foreign currency to "friendly" nations, identified as any countries other than the Soviet Union and those under the influence of the world communist movement. Com-

modities were to move through private channels to the extent possible. Foreign currencies acquired in trade were to be used for market development, stockpile purchases, military procurement, debt payments, educational exchanges, new loans, and aid to friendly countries not part of the trades.

Title II provided for grants of surplus agricultural commodities to friendly nations to meet emergency situations. Title III authorized the donation of surplus food for domestic distribution and for distribution to needy persons overseas through nonprofit relief agencies. In addition, Title III allowed for the barter of surplus agricultural commodities for strategic and other materials produced abroad.

As written, the legislation did not assign administrative responsibility. Thus, President Eisenhower still had to decide which agency or agencies would administer the various titles. After considerable bureaucratic wrangling, Eisenhower issued Executive Order 10560 on September 9, 1954. This order gave the Department of Agriculture Title I authority, the Foreign Operations Administration (FOA) authority for Title II, and the Department of State the function of negotiating and entering into agreements. The budget office received allocation authority for foreign currencies, and the Treasury Department was to regulate the purchase, custody, deposit, transfer, and sale of currencies. The Office of Defense Mobilization received authority for stockpile purchases, the Department of Defense the military procurement authority, and other various agencies authority for other foreign currency uses.

The executive order and accompanying documents also formalized the position of the interdepartmental committee that had been working for nearly a year. Known now as the Interagency Committee on Agricultural Surplus Disposal (ICASD), it was to continue to formulate policy under the chairmanship of Clarence Francis. Francis was brought into this position from the chairmanship of General Foods. Actual direction of the surplus disposal operation was to be handled by an Interagency Staff Committee on Agricultural Surplus Disposal (ISC), composed of one representative from each agency in the ICASD. William Lodwick, a Foreign Agriculture Service (FAS) official, was appointed as both administrator of FAS and chairman of the ISC.

During the first two years of operation, PL 480 was broadened to

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include feed grains and to authorize the use of federal funds to pay the costs of ocean transportation and consumer packaging. During late 1958, the Department of Agriculture developed a message that the president sent to Congress on January 29, 1959. As part of this communication, Secretary Benson inserted a "Food for Peace" section in which Eisenhower announced that he was setting steps in motion to explore, with other surplus-producing nations, means of utilizing agricultural surpluses in the interest of reinforcing peace and the well-being of friendly peoples throughout the world.

Title IV of PL 480 was enacted on September 21, 1959. It provides for long-term supply of U.S. agricultural commodities and sales on a credit basis to assist in the development of the economies of friendly nations. The program is of particular help countries that "graduate" from Title I foreign currency purchasing to dollar purchasing.

By early 1960, the original PL 480 program had been modified and extended several times. The Eisenhower administration wanted to heighten public awareness of accomplishments under the program. On April 13, 1960, Eisenhower designated Don Paarlberg as the Food for Peace coordinator. Previously, Paarlberg had been an assistant secretary of agriculture and had worked with the PL 480 program as a member of the White House staff.

The first, and least controversial, consequence of PL 480 has been the effect on food consumption in recipient countries. The diets of many thousands of people have been improved as a result of this program. There is some concern that the program has not facilitated economic development to the extent hoped for.

The effect around which there exists the most controversy and the most confusion regards the impact of PL 480 on producers and production in the recipient countries. One view holds that the surplus disposal operations of the United States have generally hurt producers in the recipient countries and, more important, have acted to remove the incentive to increase total production in those countries. In this view, the program has acted to perpetuate food shortages. An opposing view holds that PL 480 shipments have been administered in such a way as not to hurt the producers involved; through the beneficial effects on capital formation, they have acted to increase agricultural production above what it could have been without the program.

Two titles were added to the program, which became known as

“Food for Progress.” Title V is the “Farmer to Farmer Program.” It provides for a minimum of 0.2 percent of total PL 480 funds to assist farmers and agribusiness operations in developing countries by transferring knowledge of farming methods from U.S. farmers, agriculturalists, land-grant universities, private agribusinesses, and non-profit farm organizations to farms and agribusinesses in developing and middle-income countries and emerging democracies. Title VI authorizes certain activities for the reduction of debts of Latin American and Caribbean countries.

John C. Foltz

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■ 1955

DIQUAT HERBICIDE IS DEVELOPED FOR WEED CONTROL

Diquat, a nonselective herbicide, was developed for vegetation control, resulting in new methods in agriculture that conserved resources and protected the environment.

LOCALE: England

AGRICULTURAL ISSUES: Botany; Chemistry; Ecology and environment; Fertilizers; Pests and pesticides; Scientific research

KEY FIGURES

R. J. Fielden (fl. mid-twentieth century), British chemist

R. C. Brian (fl. mid-twentieth century), British researcher

R. F. Homer (fl. mid-twentieth century), British chemist

SUMMARY OF EVENT

In 1955, R. J. Fielden, a chemist with Imperial Chemical Industries (ICI) of England who was synthesizing compounds for the company's dyestuffs division, produced a new compound by combining ethylene dibromide and 2,2'-bipyridine. The resulting soluble salt, diquat dibromide, was sent to the company's Jealott's Hill Research Station in Berkshire, where R. C. Brian determined that it had a toxic effect on plants. The chemical structure was subsequently determined by R. F. Homer, who also correlated the structure with the chemical's herbicidal properties. ICI thereupon marketed diquat as well as its chemical relative paraquat. These new herbicides filled an agricultural need and caused profound changes in agricultural practices.

Diquat was proven to be benign to the environment. Although a powerful plant desiccator and contact-type herbicide, it does not have residual abilities, nor does it accumulate in the environment or in organisms. Tests of its herbicidal properties indicated that it was powerful even at very low concentrations; moreover, diquat was sold as an aqueous solution containing 20 to 25 percent of the active ingredient, which was further diluted prior to use. In part, diquat is

A WAR ON WEEDS

In "Weeds and Human Affairs," a chapter in an early textbook on weed control, the weed—an "undesirable" plant—is considered detrimental to humans. Weeds, or "noxious" plants, are described as follows:

These undesirable species of plants—weeds—profoundly affect human affairs. They concern not only the large landowner but the small farmer and the owner of the city garden plot as well. The orchardist and vineyardist must guard against invasion of noxious perennial weeds; maintenance engineers of highways, railroads, and irrigation districts have a constant struggle against weed pests; keepers of parks, golf courses, and cemeteries wage continuous warfare against turf weeds. Implement manufacturers have devised many types of farm machinery to combat weeds; seedsmen and warehousemen must purchase special equipment to remove weed seeds from those of useful species; Federal, state, and local authorities have drafted laws and regulations to curb the introduction and spread of weeds. And, finally, weeds may seriously affect public health. Some species are poisonous to livestock and humans; others, such as poison ivy and poison oak, cause severe dermatitis, and a great many cause hay fever and other allergic reactions. We cannot escape the impact of weeds upon our lives; though we may learn to live with them, and in spite of them, we cannot waver in our warfare against them.

*Source: Wilfred William Robbins, *Weed Control: A Textbook and Manual* (New York: McGraw-Hill, 1942).*

harmless to the environment because it is rapidly inactivated by sunlight; within one week or less, diquat degrades completely, leaving no residue. Even at high concentrations, no adverse effects have been observed on soil microorganisms, fungi, or invertebrates.

Diquat and its metabolic by-products have very low mammalian toxicity, and they are relatively nontoxic to grazing animals. The herbicide binds tightly to the insoluble components of a plant, so that little is absorbed by grazing animals. Less than 20 percent of the diquat dose is metabolized by animals that ingest it. Diquat residues in milk and tissue are extremely small—the substance does not accumulate even when it is fed to animals at low doses over a long period of time—and cause no ill effects in animals or in human consumers. Nor does occupational exposure to diquat result in a health hazard,

so long as workers use the product as recommended. Most important, diquat is not considered teratogenic, carcinogenic, or mutagenic; that is, it produces no birth abnormalities, cancers, or spontaneous changes in genes.

Diquat is an important herbicide not only because of its extremely low environmental impact but also because of its phenomenal herbicidal effects. The toxicity to plants, which affects only the green parts of the plant, was shown to be the result of the chemical's electron transfer properties. When diquat combines with an additional single electron it forms a free radical, which reacts with oxygen to re-form diquat and a superoxide anion. It is this superoxide anion that causes cell death. Diquat also interferes with the plant's photosynthetic mechanisms and effectively destroys enzyme systems that could metabolize and possibly inactivate it; degradation of diquat in the plant is therefore negligible. Light and oxygen are required for diquat to operate, but since it also rapidly degrades in sunlight and adsorbs tightly to soil minerals, there is little environmental impact.

Diquat is used as a plant desiccant to assist with the harvest of many crops. Residues in the harvested crops are very low, and there are no phytotoxic effects on crops planted after the herbicide application. The amount of residual diquat remaining within a crop is usually minimal but is dependent on the crop species, the rate of application, the time interval between application and harvest, and the degree to which the pod or husk was shielded from the desiccant spray. The food tolerance levels set by the U.S. government in the Federal Drug and Cosmetic Act for crops and potable water are extremely low for diquat and not exceeded by normal applications of the material. The only fatal human poisonings that have occurred were in cases of suicidal intent, and there have been very few accidental poisonings with diquat.

Diquat does not vaporize or move easily in the wind, so there is minimal spray drift. In the soil, diquat is rapidly and strongly adsorbed to clay minerals, which inactivate its herbicidal activity; how much of the diquat is adsorbed depends on the soil type, in particular on the amount of clay minerals present. Diquat is essentially immobile in soils, which prevents leaching and makes contamination of water supplies from runoff or percolation to the water table unlikely. Free diquat can be degraded by many microorganisms, but when

diquat is bound to the soil, it exerts no adverse influence on the soil microorganisms or their metabolic processes.

The speed at which diquat takes effect depends on many factors. Diquat is more effective in bright, sunny, warm, and humid weather. Rainfall does not appear to decrease the effect of the herbicide; in fact, the addition of wetters and surfactants increases its activity, whereas the presence of soil dust particles on the foliage protects the plant. Diquat in a solution of water alone is more effective than diquat in combination with fertilizers, and ground sprays producing small droplets are much more effective than those with large drops.

In water, diquat disappears rapidly (within one to two weeks), since it adsorbs to aquatic vegetation or to the bottom mud. Applications of the herbicide in the normal range are not harmful to fish and other aquatic organisms; if applied at large enough doses, however, it will kill large amounts of vegetation quickly, in turn causing oxygen depletion and posing a threat to fish. Under normal circumstances, though, diquat poses no threat to fish, and there has been no evidence of diquat accumulating within fish or within the food chain.

SIGNIFICANCE

The introduction of diquat led to a variety of new herbicide uses and new options for the farmer. Diquat was found to be highly effective in controlling common weeds, grasses, and brushwood species. Diquat has been used for the destruction of potato haulms, as a preharvest desiccant of seed crops, and as an effective inhibitor of algal growth. Since the herbicide has no residual activity, it can be used to control weeds before sowing a new crop or before the emergence of the new crop. Because woody bark tissue is unaffected by diquat, it has been possible to use the material to control unwanted vegetation without damaging established plants.

Diquat has been used in orchards, vineyards, plantation crops such as banana, sugarcane, and forests, and as a ground spray for crops. Because diquat can control unwanted vegetation on steep and sloping land, it can remove vegetation without the risk of soil erosion that is associated with traditional tillage methods. The use of a herbicide such as diquat also decreases the tillage and labor costs for farming a given area. Applications of diquat increase the development and yield of crops, which no longer have to compete for resources

Diquat Herbicide Is Developed for Weed Control

with weeds; the chemical has also been used to kill the foliage of root and seed crops to facilitate harvest.

Diquat has been used to control the flowering of sugarcane stalks, thereby increasing sugar yields, and to desiccate sugarcane before burning, thus effectively decreasing the amount of trash and again increasing the sugar concentration. Low concentrations of diquat applied to olive trees have been found to facilitate the abscission of fruits, and it has been used to control the growth of raspberry shoots and to aid in mechanical harvest. Diquat can also be used to desiccate crops such as grasses, clover, and alfalfa in preparation for long-term storage.

Initially, there was some fear that the lack of residual control of plant materials would be a major disadvantage, but it was found that diquat used in conjunction with slow-acting herbicides with residual activity resulted in total vegetation control. The introduction of diquat allowed growers to minimize both tillage and fertilizer use while maximizing the production of crops, forests, and pastures. Because diquat was nontoxic to the environment, it was a welcome addi-



Industrial crop-spraying equipment spraying an orchard. (©Michael Sheehan/Dreamstime.com)

tion to the arsenal of herbicides. In the United States, the EPA required drinking water to be tested for diquat, setting a maximum contaminant level of twenty parts per billion (ppb), and requiring water suppliers to monitor diquat if its levels rose above 0.4 ppb. A simple and effective decontamination treatment is accomplished with the use of granular activated charcoal filtering.

Michele Barker-Bridgers

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■ BEGINNING 1958

CHINA'S GREAT LEAP FORWARD BRINGS CHAOS TO AGRICULTURE

The Great Leap Forward was Mao Zedong's policy of forming communes to boost agriculture, to increase industrial production, and to make the "great leap" toward communism. However, natural disasters and mismanagement resulted in famine that killed more than thirty million people and created massive social dislocation.

LOCALE: Henan Province, People's Republic of China

AGRICULTURAL ISSUES: Agrarian reform; Collectivization; Famine and hunger; Government policy and regulation; Irrigation and water management; Natural disasters

KEY FIGURES

Mao Zedong (Mao Tse-tung; 1893-1976), chief political leader and theorist of Chinese communism

Peng Dehuai (P'eng Te-huai; 1898-1974), minister of defense who challenged Mao's economic policies

Zhou Enlai (Chou En-lai; 1898-1976), premier of China who was in favor of material incentives to encourage peasant production

Chen Yun (1905-1995), economic planner who helped China's recovery from the economic fiasco of the Great Leap

Liu Shaoqi (Liu Shao-ch'i; 1898-1969), vice chair of the Chinese Communist Party, listed as Mao's probable successor during the early 1960's

SUMMARY OF EVENT

The People's Republic of China's First Five-Year Plan (1953-1957) was coming to a close by June, 1957. The Chinese representatives at the National People's Congress were jubilant on hearing of an economic growth rate averaging 11 percent per year. China's top leaders, Mao Zedong, Zhou Enlai, Peng Dehuai, Liu Shaoqi, and Chen Yun, were worried, however, about a statistical imbalance: Industry had grown 18.7 percent, while agriculture had a growth rate of 3.8

percent. What was most disheartening to the leaders was that grain production had increased only 1 percent over the year while the population had grown 2 percent. The Chinese people already had to endure rationing in certain food items and other essentials. Now they would have to receive smaller rations because of low production in agriculture and the further need for China to repay the loans from the Soviet Union with agricultural products.

For industry to sustain its growth rate and for agriculture to improve considerably during the Second Five-Year Plan, more would have to be extracted from the Chinese population, which was 80 percent peasantry. According to Premier Zhou Enlai and the brilliant economist Chen Yun, this could be accomplished only by offering the peasants more material incentives, with the chance of being able to buy more consumer goods. Such incentives would have to be accompanied by availability of modern agricultural machinery and chemical fertilizers.

Mao disagreed with such a model because it would merely reflect the Soviet Union's development plan. Ideologically, Mao had contempt for the Soviet model because he interpreted it as a step backward from socialism and lacking in revolutionary zeal. Mao's program was based on reorganizing the social structure of the peasantry and cultivating its altruistic qualities. In short, the Chinese peasant could be exhorted to greater production by good leadership in an environment that encouraged selflessness. If Mao could achieve this, he could take the place of Soviet leader Nikita S. Khrushchev as leader of the developing world.

From late 1957 to January, 1958, 100 million peasants were mobilized to tackle gigantic projects such as building irrigation canals and dams, resulting in 7.8 million hectares of land being opened up for agriculture. This enormous task of moving millions of peasants to work on gigantic projects disrupted the normal routine of farming. There was a shortage of peasants, made up by encouraging women to work in the fields as replacements while men worked away from home. To increase peasant productivity, certain industries were relocated in rural areas so that peasants could be gainfully employed during the slack periods of the farming cycle. This mass mobilization took women away from their historical role of domestic work, so attempts were made to centralize children and meal preparations. To



expedite the process, 2 million urban party cadres were encouraged to visit the countryside to learn from the peasants and to lead them with the slogan “More, faster, better, cheaper.”

This frenzy of cheerleading and propaganda resulted in the establishment of the people’s communes in Henan Province by April. Private farms were abolished, and twenty-seven cooperatives with 9,369 households were absorbed into one large commune. By the summer of 1958, people’s communes had sprouted throughout China. Party leadership attributed the good harvest to the “Great Leap” in agricultural technique and political reforms. By December, 99 percent of the peasant population, or 120 million households, formed twenty-six thousand communes.

Morale was very high within the ranks of the Chinese Communist Party (CCP). Chairman Mao directed the creation of a new journal

for the party, called the *Red Flag*, which provided the vehicle for espousing the socialist reconstruction that was taking place and the theoretical framework for the “great leap” toward communism.

Some striking features of the Great Leap Forward were the massive entry of women into the workforce, the twenty-million-person increase in the number of clerical and industrial workers, and the need for about three million mess halls to feed 90 percent of the rural population because women had been liberated from home kitchens. Mao’s Great Leap was a scheme to transform people socially, to make them selfless and able to overcome all obstacles through sheer will. Mao believed that with correct leadership and encouragement, the Chinese could be directed toward economic transformation by “walking on two legs” to achieve both industrial and agricultural development.

With the establishment of communes, rural labor could be mobilized to work on more gigantic projects, especially irrigation, flood control, and land reclamation. Agricultural productivity could also be raised by employing more hands to plant, weed, and harvest. Light industry could then be established locally to produce consumer goods with local material and equipment. This transformation and production would breed the altruistic person who would be both “red and expert”—the communist. “Redness” would be reflected in the belief in Mao’s leadership, and “expertise” would come from practical application rather than dependence on the knowledge of the bureaucrats and intellectuals, who were being persecuted in the Anti-Rightist Campaign of 1957-1958.

To reinforce the Great Leap belief that the Chinese people could achieve miraculous productivity, Chinese, as opposed to outmoded Soviet, monumental showpieces were erected in Beijing around Tiananmen Square. The People’s Hall was built in ten months by shifts of workers from all over China. The building has an area of 1,853,568 square feet. The foyer is paved with red marble and can hold ten thousand people. The walls are of green marble and are illuminated by twelve chandeliers weighing one ton each. The auditorium has ten thousand seats, the banquet hall can seat five thousand, and the kitchen has the facilities to serve ten thousand diners. At roughly the same time, workers built a three-thousand-loom and 100,000-spindle textile factory. Workers also completed a railway sta-

tion that could accommodate 200,000 passengers a day. The effect of all these gigantic projects was to give the impression that the Chinese people could accomplish anything if they were well led, well organized, and encouraged to practice altruism.

The commune system, which eliminated most private ownership except the house and a small plot for gardening, was supposed to provide an environment for ending private gain and an atmosphere for practicing altruism. It was meant eventually to produce in such great quantities the accomplishment of the communist dream of "from each according to his ability, to each according to his needs." Thus, free from all personal wants and greed, the communist would work only for the good of all. Mao had this deep faith in "selflessness" because his personal experiences were of giving for the betterment of China. He believed that he had wanted nothing of his country and that all Chinese could be like him when they were shown the way. He saw the people's commune as the foundation of altruism and communism.

In an unprecedented campaign, Mao urged the people to produce iron everywhere. With a great surplus of iron, he thought, China could industrialize rapidly and even catch up with the United Kingdom in fifteen years. Backyard furnaces sprung up everywhere: in villages, in back streets, and in front of offices. Peasants, workers, officials, doctors, and other professionals found time to smelt iron day and night. Outrageous production quotas were set in a wild frenzy of competition. To meet them, kitchen utensils, iron beds, and even farm tools were smelted.

SIGNIFICANCE

In a single year, 1958, more than one-half billion peasants were shorn of private property and organized into a new social organization, the commune. Men and women were formed into production teams and brigades, and with military precision were exhorted to work in huge farms, dam sites, factories, and backyard iron-making furnaces. Slogans, street opera, and the media were used to urge people to work around the clock and to increase production 300 percent or more. To keep up this frenzy of production, the government provided free food, child care, and even haircuts, as if to show the Soviet Union that China was leaping over it toward communism.



Members of a Chinese commune located near Beijing assembling the harvest of the commune's corn crop in January, 1959. (AP/Wide World Photos)

As slogans and songs blared, peasants were told to plow as deep as four feet and to plant three times more seedlings in the same area of land. When harvesting was completed, farmers were urged to join students, factory workers, teachers, and other professionals to produce iron and steel. Much of the iron and steel was of such low quality that it could not be used, yet pride kept production at a high level. Much of the farmland was also ruined by deep plowing and inappropriate irrigation. Delicate machines and engines were ruined by overheating because many factories ran nonstop. Because communes were in competition, many commune officials inflated production statistics. This encouraged the setting of higher production quotas by the government, which furthered the falsification of statistics. All such setbacks were compounded by three consecutive years of bad weather.

China produced only 150 million tons of grain in 1960. This

equaled the grain production of 1952, but China had had 100 million fewer mouths to feed in 1952. Consequently, even as close as fifty miles outside the capital, Beijing, there were signs of famine. The lack of food was remedied with harsh rationing. This would cause malnutrition and illnesses that eventually killed more than thirty million people, mostly peasants, between 1959 and 1961.

As the initial euphoria of the frenetic pace of production faded because of overwork, machine breakdowns, or impossible quotas, the Chinese became disillusioned and cynical. As hunger became a reality, the people reverted to what the CCP labeled as “rightist tendencies.” The cure was to identify the criminals—the misguided and the lazy—and apply appropriate punishment. Millions were “sent down” to the countryside and to distant provinces. The more unfortunate were purged from the CCP, driven to suicide, or executed for state crimes.

The CCP faced an internal struggle to seek the appropriate ideology for development. Mao’s model would be put aside temporarily until its resurgence in the Cultural Revolution that began in 1966.

Peng-Khuan Chong

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MAGILL'S CHOICE

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1959-2002

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■ 1959-1961

FAMINE DEVASTATES CHINA

Chinese government policies, including a plan to modernize the mainly agrarian Chinese economy and society to one that was communist and based on industry, coupled with a few years of severe drought and flooding that reduced harvests, led to widespread famine and the death of thirty million or more rural Chinese people.

ALSO KNOWN AS: Great Chinese Famine; Three Years of Natural Disasters

LOCALE: China

AGRICULTURAL ISSUES: Collectivization; Drought; Famine and hunger; Flooding; Natural disasters

KEY FIGURES

Mao Zedong (Mao Tse-tung; 1893-1976), chairman of Communist China and architect of the policies that caused the famine

Lin Biao (Lin Piao; 1907-1971), Communist China military and political leader, Mao's comrade-in-arms, who was later deemed a traitor

Peng Dehuai (P'eng Te-huai; 1898-1974), marshal of the People's Liberation Army, who was the only official to directly criticize Mao Zedong's policies

SUMMARY OF EVENT

From 1958 to 1961 the people of China endured one of the most devastating famines in modern history. Although no official figures are available, an estimated thirty million Chinese perished. The famine was fueled by a policy that believed population-control programs were sinister capitalist ploys and by the belief that communist nations would always enjoy an abundance of food. All doubters in China were assailed as misguided disciples of Thomas Robert Malthus. The famine had three distinct characteristics. First, it went almost unmentioned in China and was unnoticed worldwide. Second, the causes of the famine rested squarely on the wrongheaded agricultural policies of the communists. Third, uncertainty persists about who should

bear responsibility for causing and prolonging this human-made disaster.

During the early 1950's, China had well-trained scientists knowledgeable in soil science and agriculture, but two trends combined to erode this reality: the Anti-rightist Campaign of 1957-1958 and a growing fondness for Russian communist pseudoscience among communist leader Mao Zedong and his entourage. By 1957, Mao was convinced that many intellectuals secretly withheld support for the regime and its goals. He unleashed a torrent of press harangues, show trials, struggle sessions, and mandatory self-criticism to expose and demoralize intellectuals and scientists. The result was an almost universal reluctance to criticize party policies. Joseph Stalin in Russia had been a patron of pseudoscience, and Mao emulated his practice.

Stalin had supported scientific quacks who claimed to be experts, but Mao went a step further and claimed that peasant knowledge was superior to that of trained experts. As a result, outlandish experiments of all types were deemed successful and then promoted throughout China.

The first blow to Chinese agriculture began with the promotion of backyard steel furnaces. Mao proclaimed that China could quickly match, then surpass, British steel production. Steel furnaces were inadequate to reach quotas, so the Chinese constructed low-quality backyard steel furnaces and urged people to drop their everyday tasks and smelt steel, diverting peasants from the harvest. Because wood powered most of the furnaces, the backyard steel-furnace campaign also contributed to widespread deforestation. Even in those areas where the campaign did not disrupt the harvest, it still managed to block the transport of crops to areas where food was in short supply.

In 1959, the hardship intensified as agricultural methods conformed to the reckless urgency of the mentality of the Great Leap Forward (1958-1962), a plan by the Chinese Communist Party radically to alter the country's agrarian economy of peasant farmers with modern industry and a communist society. The worst policies were close planting, deep plowing, inadequate fertilizers, pest control, irrigation, and new tools, breeds, seeds, and farm-management methods. The close-planting techniques inevitably killed the seedlings, re-



*International relief supplies
being unloaded in China
during the famine.*
(National Archives)

ardless of the crop. Hard soil was loosened with dynamite to prepare it for the deep-plowing techniques copied from Russian agriculture. In some regions in China the fields were excavated to a depth of thirteen feet. This procedure continued for years despite crop yields failing to improve, and soil fertility suffered in many regions.

Furthermore, chemical fertilizers were seldom used. Instead, the Chinese followed the advice of Russian biologist and agronomist Trofim D. Lysenko, who believed that a mixture of one part manure and nine parts soil was as good as pure manure. The diluted manure failed, contributing to poor harvests. Irrigation projects of this period frequently did more harm than good. With very little equipment to employ, the dams and canals were built by unskilled laborers, including thousands of students who left school to work. Peasant “engineers,” who had no specialized training, replaced durable and expensive materials with flimsy alternatives. As a result, many of the dams collapsed after a short time, creating additional hardship.

The nationwide effort to kill all sparrows caught the attention of the rest of the world and symbolized the futility of Chinese commu-

nist policies. Mao had declared that grain production was the top priority, and decreed flocks of sparrows the biggest obstacle to abundant harvests. The campaign involved millions of children, who were told to bang pots and pans near the nests of the birds so that the sparrows would fly frantically until they dropped from the air in exhaustion. The campaign achieved its goal, but with the sparrows eradicated, insect pest populations skyrocketed. Rather than admit he made a major mistake, Mao simply launched into a mass campaign against insects. The policies begun in 1958 to eradicate insects were disastrous as well. The failure to reverse these policies was tragic. Most critics were too cowed to speak out, and officials at every level turned in inflated statistics to avoid denunciation. The handful of accurate reports that made it to leaders were misinterpreted. When Mao heard of food shortages, he concluded that peasants were hoarding crops, and he ordered harsher grain collection policies that added to the hardships.

The fragmentary reports that emerged after the famine painted a relentlessly grim picture of malnutrition, disease, and hopelessness in the face of harangues to work even harder. Once starvation set in, the weakened survivors were unable to bury the dead, adding to the widespread horror. All this went unmentioned in the press, which continued to portray a land of abundance and to predict a glorious future for China. One leader, the venerable Peng Dehuai, confronted Mao. At a meeting in Lushan in 1961, Peng scolded Mao for ignoring the suffering of the peasants. After a brief period of shock, Mao counterattacked viciously, ruining the career of Peng and choosing Lin Biao to replace him, but with disastrous results.

By late 1961 the Chinese economy was in grave disarray, and Mao agreed to a modest retreat from the harmful policies. Local leaders and groups of peasants used the retreat to undo much of what had been ordered. Rural hardship did not end, but the monumental suffering of those horrific years subsided. Unlike the Cultural Revolution of 1966 to 1976, which continues to be widely discussed in China, the famine was rarely examined, and its lessons went unlearned. Even more troubling is that Chinese environmental policies still reflect a reliance on accelerated economic development; the consequences of these policies for the environment remain afterthoughts.

Famine did not return to rural China, but widespread hardship re-

mained. The result was a mass exodus of peasants to the cities, creating massive social dislocation. What was billed as a peasant revolution in modern China produced a society that disregards the plight of peasants and plunders nature.

SIGNIFICANCE

For two hundred years, famines have resulted largely from human actions and not from natural causes. The famine in China from 1958 to 1961 is a glaring example of a human-made disaster. By 1958, China had been able to feed its massive population. Unwise policies and stubborn reluctance to admit blunders disrupted Chinese agriculture with horrific results.

Some evaluations of the famine portray Mao as the sole culprit. Certainly his attitudes and his demand for blind obedience played a role. Other evaluations stress near-universal attitudes that asserted that nature was expendable and that development was worth any cost. Both approaches overlook the fact that China had become a major actor on the world stage by 1958, and the Sino-Soviet split and other tumultuous events surely distracted Mao from domestic problems.

Disputes over who or what is to blame for the famine may never be solved, but much more disturbing is the dearth of contemporary reporting on the famine and the paucity of historical studies. Famine in China and worldwide remains devastating and misunderstood, a sad result of human indifference to suffering.

Michael Polley

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■ FEBRUARY, 1962

UNITED NATIONS ESTABLISHES WORLD FOOD PROGRAMME

The U.N. World Food Programme, first envisioned as a three-year experiment, formed as a multilateral aid program to distribute surplus foodstuffs to the world's hungriest people. The program continued into the twenty-first century.

LOCALE: Rome, Italy

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Famine and hunger; International food relief

KEY FIGURES

Binay Ranjan Sen (1898-1993), Indian diplomat and director general of the Food and Agriculture Organization, 1956-1967

John F. Kennedy (1917-1963), president of the United States, 1961-1963

Dwight D. Eisenhower (1890-1969), president of the United States, 1953-1961

George McGovern (b. 1922), senator from South Dakota

Addeke Hendrik Boerma (1912-1992), first executive director of the World Food Programme

John Boyd Orr (1880-1971), first director-general of the U.N. Food and Agriculture Organization

SUMMARY OF EVENT

One of the earliest goals of the United Nations was the eradication of world hunger. To this end the U.N. founded the Food and Agriculture Organization (FAO) in 1945. During the 1940's and into the 1950's wealthier nations had begun to discuss the possibility of donating surplus foodstuffs to nations extremely short of food. Already in 1946, John Boyd Orr, the director-general of the FAO, proposed the creation of a world food board to improve nutrition throughout the world, to create reserves of food as a defense against crop failure, to distribute surplus food to the most needy, and to stabilize agricultural prices. This proposed program proved to be too ambitious for the time, and thus failed to garner adequate support.

Interest in international hunger relief continued. The FAO studied global hunger during the 1950's. Meanwhile, the United States confronted the problem of the costly and wasteful storage of surplus agricultural products. In 1954, U.S. president Dwight D. Eisenhower signed into law the Agricultural Trade Development and Assistance Act, which aimed to alleviate hunger using surplus food for people in the United States and abroad. This act was modified in 1960 to enable food-aid grants in addition to sales and to foster development projects. In an address to the U.N. General Assembly on September 22, 1960, Eisenhower proposed a special multilateral program for the distribution of surplus food. In October, the General Assembly passed a resolution to establish an international program for food aid. Binay Ranjan Sen, director-general of the FAO, organized a panel of experts to devise strategies for food collection and distribution on a worldwide scale.

U.S. president John F. Kennedy also supported the establishment of a world food program. In fulfillment of campaign promises, he signed two executive orders, one on January 21 and another on January 24, 1961—immediately after his inauguration—to increase food aid to unemployed Americans and to expand the international goals of the assistance act of 1954, which he renamed the Food for Peace program. The program's first director, U.S. senator George McGovern, proposed to the FAO in April that a three-year experimental international food-relief program be established. Kennedy fully supported the proposal. On September 25, Kennedy addressed the General Assembly with an initiative to name the 1960's the "United Nations decade of development." While the United Nations focused on food relief for development, McGovern envisioned the program as one of relief alone.

On November 24, soon after Kennedy's address, the United Nations established the World Food Programme (WFP). Its governing body met for the first time the following February and designated its goals: food security and the distribution of surplus food, not only for emergency relief but also, more important, for social and economic development. The WFP became fully functional in June when Addeke Hendrik Boerma assumed the position of executive director. The first requests for aid came from Iran, which experienced an earthquake that killed twelve thousand people in September; from

WORLD FOOD PROGRAMME MISSION STATEMENT

The U.N. World Food Programme defined its mission as being “the food aid arm of the United Nations system.”

Food aid is one of the many instruments that can help to promote food security, which is defined as access of all people at all times to the food needed for an active and healthy life. The policies governing the use of World Food Programme food aid must be oriented towards the objective of eradicating hunger and poverty. The ultimate objective of food aid should be the elimination of the need for food aid. . . .

Targeted interventions are needed to help to improve the lives of the poorest people—people who, either permanently or during crisis periods, are unable to produce enough food or do not have the resources to otherwise obtain the food that they and their households require for active and healthy lives. . . .

Thailand, hit by a typhoon in October; and from Algeria, whose battle for independence had created five million refugees.

The WFP was established as a nonpolitical entity, and it distributes aid according to need only. Donor countries make their surplus food available for all, or they provide funds to pay for the food’s distribution. Unlike other food-relief efforts, the WFP takes a project approach. This approach involves the allocation of resources through international agencies to particular projects, such as food for work or nutritional supplementation for vulnerable groups, especially mothers and young children, and not to governments for distribution and sale. During the early years the program devoted about two-thirds of its food aid to development. A reforestation program in Algeria, for example, used workers paid in food by the program. Proponents of this approach argue that the aid reaches the poor more efficiently, though the costs may be greater using this approach.

One of the earliest goals of the WFP was to reduce the number of bilateral arrangements for food aid, which tended to be more costly and less efficient. As a centralized agency, the program gained expertise and efficiency in the distribution of food, especially during emergencies. During the early years of the program, the FAO created several support initiatives for the program, including the Freedom from Hunger Campaign.

The WFP's provisional period was very successful, and so the United Nations approved its continuation in December, 1965, for as long as the program was necessary and effective. By this time, more than one hundred countries had provided aid, and contributions had fallen just \$6 million short of the goal of \$100 million. The program had responded to more than thirty major emergencies in twenty-five countries and aided more than one hundred social and economic development projects. Some problems still existed, however. The United States contributed more than half of all the resources during the provisional period, though officials hoped that other nations would share more of the burden. Relying on a single donor could jeopardize the program.

SIGNIFICANCE

According to advocates of the World Food Programme, its "project approach" holds advantages over the "program approach" used by other relief initiatives. Because the program approach entails the sale of food aid from one government to another, aid is less likely to reach the desperately hungry. Moreover, unlike Food for Peace, in which food aid was a foreign policy instrument, the WFP distributes food without political considerations.

Some difficulties with the program did emerge, however. Over the decades, it became apparent that the WFP enjoyed much more success as a responder to emergencies, which increasingly resulted from human causes. The results of development programs were mixed, with school lunch programs being most successful. Over the years the goals and initiatives of the WFP have undergone assessment and revision. To take one example, the program recognized the importance of women's empowerment.

Finally, a consideration of the moral dimension to food aid is necessary. Food aid traditionally has been a moral imperative, but it also has been recognized that food aid should not lead to disincentive—to the inability or unwillingness of nations to support themselves in times of crisis. Some critics of food aid actually argue that such aid is immoral because it leads to increased population and mass starvation. Demographic studies have not borne out this argument, and so the World Food Programme continues to aid the world's hungry and starving.

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■ SEPTEMBER 30, 1962, AND SEPTEMBER 16, 1965

UNITED FARM WORKERS OF AMERICA LEADS GRAPE PICKERS' STRIKE

Union leaders formed the United Farm Workers of America, the first permanent agricultural workers' union in the United States, and led a major strike of grape pickers. The strike ended with growers agreeing to union demands, leading to the largest victory in the history of farm-labor organizing. The strike also raised public awareness of farmworker rights.

ALSO KNOWN AS: National Farm Workers Association (NFWA)

LOCALE: Fresno, California

AGRICULTURAL ISSUES: Agrarian reform; Labor; Migration

KEY FIGURES

César Chávez (1927-1993), farmworkers' rights activist and leader of the United Farm Workers of America

Dolores Huerta (b. 1930), farmworkers' rights activist and cofounder and vice president of the United Farm Workers of America

Ernesto Galarza (1905-1984), farmworker, labor organizer, scholar, teacher, and civic leader

SUMMARY OF EVENT

Throughout the twentieth century farmworkers have struggled to organize themselves against a politico-agribusiness complex that has been rather successful at resisting them. Only since the mid-1960's have working conditions for farmworkers begun to improve substantially. Improvements in income and working conditions are direct results of the termination of the federal bracero program as well as the struggles for union recognition and collective bargaining by the United Farm Workers of America (UFW) and its organizational predecessors, the National Farm Workers Association (NFWA) and the United Farm Workers Organizing Committee (UFWOC).

The September, 1962, founding of the NFWA in Fresno, California, by César Chávez, Dolores Huerta, and others signaled a new era in the efforts by farmworkers to unionize and bargain collectively

SEPTEMBER 30, 1962, AND SEPTEMBER 16, 1965

with their employers, mostly large agricultural growers. In 1966, Chicanos and Mexicans in the NFWA and Filipino farmworkers in the Agricultural Workers Organizing Committee (AWOC), an affiliate of the American Federation of Labor-Congress of Industrial Organizations (AFL-CIO), merged organizations to form the UFWOC. In February of 1972, the UFWOC became a full-fledged affiliate of the AFL-CIO and formed the UFW. In 1975, struggles by the UFW culminated in the passage of the Agricultural Labor Relations Act (ALRA) by the California legislature.

Led by Chávez and Huerta, the NFWA brought years of community organizing experience to bear on the problems of farmworkers. These problems included economic hardship, general powerlessness against employers, and the lack of adequate facilities in the fields. The NFWA was established as an independent, service-oriented, Chi-



César Chávez in 1966.
(Library of Congress)

cano farmworkers' labor organization that provided credit, burial, and other family services. It sought to organize farmworkers one by one.

Prior to the 1960's one important factor hindering the unionization of farmworkers was the bracero program, which was established under the Emergency Labor Program of 1942 to ease the labor shortage brought on by World War II. The bracero program supervised the recruitment of Mexican nationals to meet U.S. growers' demands for labor. It was continued by Public Law 78 after the end of World War II and was maintained until 1963, when the law expired.

During the 1950's, Mexican braceros greatly influenced the unionization of U.S. farmworkers. By serving as alternate sources of cheap labor, they often were used as strikebreakers by growers. In 1947, the newly founded National Farm Labor Union (NFLU) led a strike against the powerful Di Giorgio Fruit Corporation in Arvin, California. The union demanded an increase in wages, seniority rights, grievance procedures, and recognition of the union as sole bargaining agent. Robert Di Giorgio refused the demands and launched an assault on the NFLU. He used braceros as strikebreakers and manipulated both the press and politicians in his favor. The U.S. House Committee on Un-American Activities began investigating the union. In 1949, a special subcommittee of the House Committee on Education and Labor held hearings on the Di Giorgio strike. The committee supported the growers and Di Giorgio won the strike.

This particular strike taught Ernesto Galarza, one of the strike leaders, an important lesson in the struggle between farmworkers and growers. In his view, farmworkers could not be organized until growers' access to exploitable immigrant labor groups was halted. Braceros, as international migrant workers, were more exploitable than American workers. If they tried to organize, they were labeled as communists and deported. Those braceros seen by growers as causing unrest among farmworkers were often reported to the Immigration and Naturalization Service, the Department of Labor, and the Department of Justice, each of which would investigate the "leaders" for violations of U.S. laws. Consequently, during the 1950's, there was not a single strike by braceros, although the NFLU continued to organize strikes among other farmworkers.

By 1962, the year the NFWA was founded, economic conditions

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for farmworkers had worsened because of increased mechanization on farms and the continued negative impact of the bracero program on unionization efforts. In 1965, farmworkers in Tulare County, California, lived in dilapidated labor camps condemned by the Tulare Housing Authority. The labor camps had been built by the U.S. Farm Security Administration near the end of the Great Depression to provide temporary shelters for Dust Bowl migrants. Condemnation led to rent increases meant to yield the necessary revenue to build new housing. Late in the summer of 1965, the NFWA led rent strikes among farmworkers. The rent strike at Woodville, one of the labor camps, evolved into an employment strike at the nearby J. D. Martin Ranch. Strikers complained about low pay, the lack of toilets in the fields, and a peeping crew boss. The strike failed. Within two weeks, however, the NFWA became involved in a strike for higher wages initiated by the Filipino membership of the AWOC local at Delano.

On September 16, 1965, the NFWA formally joined the Delano grape strike. Four days later NFWA picket leaders asked farmworkers to walk off the fields. The AWOC-NFWA strike spread throughout the Delano-Earlimart-McFarland area, affecting approximately thirty ranches and involving several hundred farmworkers. Hundreds of college students, civil rights workers, and religious groups joined the farmworkers within days of the onset of the strike. Civil rights organizations quickly sent members of their staff to help with the strike. In October, under the charismatic leadership of Chávez, the NFWA launched a grape boycott.

Supporters quickly started picketing stores and piers throughout California. In response, growers began to bully picketers, often in the presence of law enforcement officials who did nothing to stop them. Growers also resorted to spraying sulfur near the picket lines. The strike continued to gain momentum, and within two weeks nearly four thousand farmworkers were out of the fields. Many growers were not economically hurt because they were able to import workers from neighboring cities who were willing to cross picket lines to work. Strike leaders began to spread word of the strike to farmworkers in neighboring areas.

In March, 1966, the U.S. Senate Subcommittee on Migratory Labor conducted public hearings in Delano and other nearby cities. At the Delano hearings, Senator Robert F. Kennedy, a member of the

subcommittee, reminded the local sheriff to brush up on the rights of all people, including farmworkers. In 1966, some growers slowly began to settle with the strikers; others continued to hold out, turning instead to the International Brotherhood of Teamsters for "sweet-heart contracts." The strike continued through the years 1966 and 1967. In 1968, the union, now called the United Farm Workers Organizing Committee (UFWOC), extended its boycott to include every California grower of table grapes. Slowly, more individual growers agreed to recognize the union, but many powerful others continued to hold out. Finally, in July of 1970, UFWOC scored the largest victory in the history of farm-labor organizing when several of the most powerful growers agreed to the union's demands, thereby officially ending the strike.

SIGNIFICANCE

The major consequences stemming from the founding of the National Farm Workers Association in 1962 were the eventual establishment of a permanent farmworkers' labor union and passage of the Agricultural Labor Relations Act (ALRA) in California in 1975. The farmworkers forced growers to recognize their union and to agree to collective bargaining. This meant improvements in wages and working conditions for farmworkers.

Mexican immigrants, Chicanos, and other poor groups have provided a steady supply of cheap labor to agribusiness, especially in the Southwest. In order to maintain access to cheap labor and to thwart unionization efforts, growers have generally been highly supportive of unrestricted immigration from Mexico. Efforts by farmworkers to organize unions and bargain collectively have been brutally suppressed by growers, who often have had local criminal justice systems and federal immigration agencies on their side during periods of labor disputes. Growers' use of sheriffs, police officers, judges, strike-breakers, and private armies against farmworkers were common. Indeed, the U.S. government itself, through the bracero program, was a "labor contractor" for growers.

The NFWA, which changed its name to the United Farm Workers of America (UFW), brought the plight of the farmworkers to the forefront of America's conscience and highlighted the suffering and indignities farmworkers were forced to endure. It also marked the

inception of the farmworkers' first permanent, broad-based organization. Chicano and Filipino farmworkers, long neglected by labor legislation and traditional trade unions, organized their own independent labor union and assumed their rights to organize and bargain collectively with their employers.

The Delano Grape Strike, begun in September of 1965, propelled César Chávez, Dolores Huerta, and the NFWA to the front of the civil and labor rights struggles. Chávez turned the strike into a crusade by promoting the view that farmworkers are human beings who deserve respect and a living wage. In 1968, he fasted for twenty-five days to gain support for the farmworkers' struggle. He ended the fast by "breaking bread" with Senator Robert Kennedy, then a candidate for the U.S. presidency.

Through use of the consumer boycott, farmworkers were able to involve the American public in their struggle for human and union recognition. As a result, Americans "discovered" the farmworkers, who through their own efforts affirmed and reclaimed their humanity, though their struggle for justice continues.

Rubén O. Martinez

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■ 1964

HIGH-YIELD RICE FOSTERS GREEN REVOLUTION

In a development that became known as the “Green Revolution,” the adoption of high-yield, high-input rice strains in many developing nations—particularly in Asia—greatly increased food production and tended to reorganize agriculture to follow the American model.

LOCALE: Los Banos, Philippines

AGRICULTURAL ISSUES: Ecology and environment; Fertilizers; Genetic engineering; Mechanization; New crops and food products; Pests and pesticides; Scientific research

KEY FIGURES

Robert F. Chandler (1907-1999), American agricultural scientist

Norman Borlaug (b. 1914), American plant pathologist

M. S. Swaminathan (b. 1925), Indian agricultural official

SUMMARY OF EVENT

At the International Rice Research Institute (IRRI) in Los Banos, the Philippines, in 1964, a new variety of rice was bred which, with the addition of sufficient water, fertilizer, and pesticides, among other things, would double rice production in much of Asia. This new seed, in conjunction with high-yield variety wheats already developed, led to vast social and ecological changes as small, diverse agricultural plots farmed with traditional methods were converted to larger, single-crop fields throughout the world.

The plant-breeding program at IRRI was an extension of work done during the 1940's by Norman Borlaug, an American plant pathologist, in a joint program between the Mexican Ministry of Agriculture and the Rockefeller Foundation. Borlaug developed the first high-yield wheat by interbreeding local varieties with seeds from around the world to incorporate high productivity, disease resistance, and some degree of adaptation to local conditions. The new hybrids had tripled wheat production in Mexico in six years. Contrib-

uting to Borlaug's success was the team of young Mexican agricultural scientists he trained and sent into the field, which became part of the model copied at IRRI.

The International Rice Research Institute was created in 1962 under the direction of Robert Chandler, a former president of the University of New Hampshire. Chandler and the Rockefeller Foundation, joined by the Ford Foundation, wanted to do for rice, the staple food of Asia, what Borlaug had done for wheat. They were concerned that, although population growth was climbing in Asia and other developing areas, food production was not keeping pace.

IRRI's goal was in line with a change in U.S. foreign aid policy. Previously, the United States had shipped food directly to countries in need; after 1965, the policy was changed to encourage increased agricultural production in those countries. Much of that encouragement took the form of shipments of fertilizers, without which the new hybrid seeds could not perform their miracles. Critics have pointed out that new advances in fertilizer production during the mid-1960's by the Kellogg Corporation had created a glut on the fertilizer market in the United States, leading Kellogg to seek the development of new markets abroad.

In two years, Chandler's scientists at IRRI announced the development of a strain of rice called IR-8. IR-8 was bred from a cross between a tough, productive strain from Indonesia and a dwarf rice from Taiwan. No sooner had IR-8 been hailed as the new miracle crop than dissemination of it began around the globe. The new crop was soon found, however, to be susceptible to a range of diseases and pests. In 1968 and 1969, it was devastated by bacterial blight, and in 1970 and 1971, it was devastated by a tropical disease called tungro. As Norman Borlaug had found earlier with his strains of wheat, the effort to develop new resistant varieties had to be constant. In 1977, the first rice variety with resistance to multiple diseases was released, only to be attacked by a previously unknown virus, and so the cycle continued.

When disease struck fields planted in the hybrids, destruction was complete. The new fields were a simplified ecosystem of one crop or monoculture. All the other species of plant which could have helped interrupt the spread of disease had been eliminated. Moreover, all the plants, being genetically identical, were identically vulnerable.

The promise of increased yields drew millions of farmers each

year to try the new wheat and rice. In India, this process was initiated by M. S. Swaminathan, an agricultural official who invited Borlaug to India in 1963 for consultation. Borlaug convinced him to try the new Mexican wheat and the farming methods it required. By 1965, Swaminathan had committed India to try the new process on a massive scale. Despite resistance to the new methods, Indian farmers were persuaded to try. By 1968, India's wheat production increased by five million tons, and by the early 1970's, India was self-sufficient in grain, as was the Philippines.

In Mexico, the existing research program was turned over to the Mexican government, and a new organization, the International Corn and Wheat Improvement Center, was created. Additional backing came from the Kellogg Foundation as new research centers were established in Nigeria in 1965, Colombia in 1968, Liberia in 1971, and Peru and India in 1972. By 1971, however, the foundations sought to divest themselves of this network, and a consortium of foundations, governments, and agencies of the United Nations, called the Consultative Group on International Agricultural Research, was formed to take over the funding.

By the 1970's, as a result of the work of these institutes, high-yield wheat or rice or both were grown in Iran, Algeria, Morocco, Tunisia, Iraq, Saudi Arabia, Turkey, Kenya, Egypt, Pakistan, Brazil, Indonesia, Ceylon, Burma, Vietnam, and other countries.

As for the recurring problems of eruptions of new diseases and pests, the emphasis shifted at IRRI and the other research programs to breeding for improved hardiness and disease resistance rather than for further increases in yield.

SIGNIFICANCE

Some critics have called the term "high-yield varieties" a misnomer, because in anything less than ideal conditions, the new crops performed less well than the crops they replaced. Large quantities of fertilizer were the primary input which the new seeds required, but they also needed a constant and plentiful water supply, which in many areas entailed large-scale irrigation projects. Since the new breeds were as a rule less pest-resistant than the old, pesticides were also a prerequisite. Machinery replaced labor in preparing the land and harvesting the grain. Higher yields were also achieved because fields were

planted two or more times per year. Taken as a whole, the hybrids represented a radically different system of agriculture, with significant social and environmental impacts.

In the social realm, although the Green Revolution created the possibility of solving world hunger by dramatically increasing yields, in many places it led instead to the further impoverishment of small farmers who could not afford the inputs required. In Indonesia, it has been estimated, only 25 percent of peasant farmers benefited from the Green Revolution. As the hybrid seeds came into use, many farmers lost their land and became day laborers in the countryside. Others migrated to the cities, contributing to the further crowding of urban areas, while the larger landowners prospered and bought up the abandoned farms. Indeed, when the Mexican government initiated the first research program, the reduction of the farm population had been as much a goal as the increase of the food supply.

The new agricultural system changed communities that had been relatively self-sufficient in food to communities dependent on seeds and inputs from the United States and multinational corporations. While IRRI and the other research institutes aimed to stimulate local production of fertilizer, that has been the exception, with Kellogg and other corporations remaining the chief source. In the Philippines, for example, as the new hybrids were introduced, the Rockefeller-owned Standard Oil Company set up four hundred agroservice centers, which sold ESSO fertilizer and inputs.

The Green Revolution has had an equally significant impact on the environment. The old agricultural ecosystem of subsistence-style farms was based on small fields, often intercropped, often broken by hedgerows, windbreaks, or streams, often including fields that lay fallow to let the soil regenerate. Insects, animals, and birds remained part of the environment.

The large-scale farm machinery of the new system required larger fields. Hedgerows and even streams were destroyed, while pesticides eliminated insects and animals. As high yields depended on the maximum possible number of plantings, soil could not be allowed to lie fallow. Fertilizer supplied the nitrogen necessary for fertility, leaving the soil, after harvesting, again depleted.

One ton of petroleum is required to produce two to three tons of fertilizer. When the Organization of Petroleum Exporting Countries



*Asian farmer working
in a rice paddy. (Corbis)*

(OPEC) raised its prices in 1973, the price of fertilizer in Southeast Asia rose from \$50 to \$225 per ton. In its dependence on this nonrenewable energy source necessary for pesticides and machinery as well as the production of fertilizer, the new agricultural system was vulnerable. Moreover, the environmental costs of extracting, refining, and shipping petroleum on an unprecedented scale had to be included in its price tag.

Although before the Green Revolution pesticides were virtually unknown in developing nations, since then their use has climbed steadily. Few governments there thought to regulate pesticide use or had the means to do so. As dichloro-diphenyl-trichloroethane (DDT) and other substances were banned in the United States, companies shipped their stocks to the less-developed countries for sale.

High illiteracy rates and repressive working conditions often complicated these problems. Health statistics are often unavailable or partial in many developing countries, but the World Health Organization estimated in 1979 that five thousand people died, one-half of whom were children, and one-half million more were poisoned by direct contact with pesticides. A 1979 survey of five major markets in Bangkok reported pesticide residues in over three-quarters of the rice and flour, and every freshwater fish tested was contaminated.

Pesticide use in Green Revolution countries has led to contamination of people, land, and water there, and pesticides have also found their way back to the United States and Europe in food imports. Furthermore, new generations of pesticide-resistant pests develop continually. These superpests have contributed to crop failures around the world, and to the collapse of some agricultural industries.

The Green Revolution has also contributed to a larger problem, the diminishing of genetic variety worldwide. Only fifteen species of plant, three of which are rice, corn, and wheat, provide 85 to 90 percent of human energy. As genetically identical hybrids spread throughout the world, they take the place of locally adapted crops, which are lost forever. The new strains were created by the interbreeding of just such crops from around the world, and as scientists seek to develop new hybrids in response to outbreaks of disease, they are beginning to find the genetic material they need already gone. All of this notwithstanding, there can be little doubt that the expanding production of food saved countless millions from starvation.

Maya Muir

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■ 1964

NEGEV DESERT IRRIGATION EXPANDS ISRAELI AGRICULTURE

After years of indirect overtures to uncooperative neighboring states, Israel carried out a unilateral system to bring Jordan Valley water to the Negev Desert. In addition to making irrigation possible and expanding Israeli agriculture accordingly, the project proved to have significant archaeological and diplomatic consequences.

LOCALE: Israel

AGRICULTURAL ISSUES: Archaeological discoveries; Irrigation and water management

KEY FIGURES

James B. Hays (1889-1953), American chief engineer for the Commission on Palestine Surveys

Eric A. Johnston (1895-1963), private U.S. envoy to Israel appointed by President Dwight D. Eisenhower

John S. Cotton, American agricultural adviser

SUMMARY OF EVENT

After the creation of Israel as a Jewish state in 1948, a number of plans that envisioned Arab-Israeli cooperation were presented to bring water to the Negev Desert region. Among them were the Hays Plan, the Johnston Plan, and the Cotton Plan. Because of the political climate of the Middle East, however, none of these plans as originally formulated was put into action: In each case, either Israel or neighboring Arab states argued that the plan favored one or the other. During the late 1950's, Israel, without Arab cooperation, decided to construct a pipeline system along the Mediterranean coast. The first water flowed through the pipeline to the Negev region in 1964, enabling settlement and agriculture in the region to increase.

United Nations Resolution 181 had partitioned the British-mandated territory of Palestine into two zones in 1947. One zone was to be reserved for a future state of Arab Palestine. The second zone,

comprising Galilee in the north, the west central region including Tel Aviv near the coast, and the triangular mass of the Negev Desert in the south, became the independent state of Israel in May, 1948.

Although there was major political disagreement over the U.N. decision that had led to the creation of the modern state of Israel (disagreement that would lead to Arab-Israeli wars in 1948, 1956, 1967, and 1973), one clear fact had to be recognized, whatever the political future of the region might hold: Scarcity of water would continue to limit the agricultural productive capacity not only of Israel but also of all its immediate neighbors. Inside Israel itself, concerns about areas already identified as attractive to potential Israeli settlers were more acutely applicable to the barren Negev zone.

Israel proved to be eager to develop the potential of all the land that the U.N. partition gave it, including the apparent wasteland of the Negev Desert. In fact, the new state of Israel already had well-defined plans for the use of state-of-the-art engineering techniques to bring water to areas of Palestine that could then support a carefully calculated level of population and local economic activity. Some of these plans came from well-intentioned outsiders who, in addition to fulfilling contractual assignments from individual governments or U.S. agencies, supported the idea that mutual advantages would come to both Israel and its neighbors if they cooperated in sharing engineering technology and applying it equally to the Syro-Lebanese, Jordanian, and Israeli segments of a regionwide hydraulic development plan.

The first such plan, published in 1948 by James B. Hays of the American Society of Civil Engineers, was based on the premature assumption that the 1947 Partition Plan, with its specific provision for "joint economic development" between Israel and a new Palestinian Arab state, would make joint hydraulic engineering projects possible within the total areas constituting historic Palestine proper. Since joint economic development did not materialize, Hays recognized that there had to be backup engineering contingencies. These could allow Israel to proceed independently if it did not receive cooperation from Jordan specifically and Lebanon and Syria generally.

Hays's plan, referred to as the Jordan Valley Authority (JVA) after the Tennessee Valley Authority (TVA) experiment in the United

States, aimed at coordinating effective management of northern Palestine's water resources with the goal of bringing at least minimal amounts of water into the Negev. Although Hays stated that the JVA should copy the strict soil conservation practices and other ecological standards applied by the TVA, his report makes it clear that, in 1948, the main objective of the plan was to provide a way to open these extensive arid spaces (nearly two-thirds of Israel's total surface) to as many displaced Jews as possible. In many respects, therefore, the proposed JVA was based on questions of political and technical expediency for colonization in the particularly stressful period after independence was gained. Ecological considerations seem to have been less important than the numbers of hectares that could be reclaimed from the desert. By 1964, considerably more attention would be given to the ecology of the Negev area targeted for "imported" water.

A total of seven pre-Negev stages of the 1948 JVA proposal had to be completed (completing all seven would be optimal, but functioning with fewer segments would be possible, depending on degrees of cooperation from Arab neighbors) before the eighth and final stage could bring water to the Negev. A main characteristic of stage eight of



Villagers collecting water at a Negev Desert well long before the irrigation project was conceived. (Library of Congress)

the JVA (as well as all subsequent plans that included the Negev as a target area for imported water) was that the Negev would obtain all surplus waters collected from prior stages engineered to provide water to the more accessible northern areas of Israel for transmission via a coastal collector canal into the Negev zone.

Essential to any examination of the problem of bringing water into the Negev was a calculation of the “duty of water” for prospective recipient subregions. The duty of water calculation combines estimates of surface evaporation as a result of average annual accumulated heat with estimated annual rainfall. These totals are then subtracted from the estimated total water required to grow certain types of crops on a given surface—a *dunam* in Israel—under carefully controlled conditions. The resultant duty represents the amount of water that must be imported into a given region. Hays found that the duty of water in Gaza, just outside the Negev Desert, would be 827 cubic meters per year per *dunam*. In the Negev Desert proper, substantial differences divided the Beersheba zone in the northern Negev, ranging from 999.5 to 958 cubic meters, from the southern Negev, where the duty of water was substantially more than 1,050 cubic meters. Already in the north, the added need for water to service the Beersheba zone was 19.5 percent higher than the need of the Beit Hanun-Rehovot area directly north of Beersheba (with a duty of water of 802 cubic meters).

Using these calculations, the JVA estimated total costs that would be involved in gathering surplus water from the first stages of the project and delivering it to different areas of the Negev for agricultural use. The goal was the irrigation of a total of 342,000 *dunams*: 100,000 in Beit Hanun-Rehovot, 162,000 in the northern Negev, and 80,000 in the southern Negev. Variable duties of water in the three zones brought the estimated total of water needed annually to 319,700,000 cubic meters. In 1948 dollars, the total cost estimate for including the Negev Desert in the JVA, including capital costs for minor runoff valley dams, canals, siphon systems, booster pump stations, and tunnels, came to \$53,882,000, an average of \$157.50 per *dunam*.

For nearly four years, the initiative represented by the Hays Plan remained dormant as various attempts at achieving political and military peace via the U.N. Conciliatory Commission on Palestine stalled and then stopped. Subsequent initiatives by internationally

sponsored agencies or individuals, such as the Johnston Plan and the Cotton Plan, which formed the basis for actions taken by Israel during the mid-1960's, were no more successful than the Hays scheme in overcoming political obstacles created by Arab-Israeli hostilities.

In 1953, President Dwight D. Eisenhower named Eric A. Johnston, of the Motion Picture Association of America, as his personal emissary with the job of reviewing the JVA water question with both the Arab states and Israel. Johnston had two key means of persuasion: a U.N. Relief Works Agency-commissioned JVA study carried out by a private company working for the American TVA, and Eisenhower's tacit agreement that the United States would help pay for a unified Arab-Israeli development effort. This plan combined key elements of the Hays scheme and a second approach suggested by private advisers of the Jordanian government. Important differences between the Johnston Plan and Hays's 1948 proposal affected Israeli hopes to bring water to the Negev. Israelis also objected to what they considered Johnston's miscalculation of realistic irrigation possibilities in the lower Jordan Valley. They claimed that if too much water was removed for Jordan's use, not enough would be left to meet Israel's needs.

The main consequence of Israel's reaction to the Johnston Plan was a counterproposal called the Cotton Plan, prepared by John S. Cotton. The Cotton Plan had one new and one old element in it that made it attractive to Israel. The new element, which would destroy prospects for cooperative development of a total water system among Israel and its Arab neighbors, was a proposal to tap water from the Litani River in Lebanon for purchase by Israel. Cotton estimated that Lebanon had effective need for only about one-half of the water flowing into the Mediterranean, and that the addition of Litani River water would have a major impact on the "old factor" he carried over from the Hays Plan of 1948: creation of a substantial water surplus that could be brought via a coastal canal to the Negev. These two factors (particularly Arab opposition to the diversion of Litani waters into a system that would work to Israel's long-term benefit) led to the failure of the international round of discussions sparked by the Johnston mission.

After the 1956 Suez Canal crisis, which dashed all parties' hopes



Portion of the Negev Desert under irrigation. (©Yosef Erpert/Dreamstime.com)

for a political settlement of the Arab-Israeli conflict, the Tel Aviv government decided that the future of its claims to Jordan River water would depend upon its own plan of action. It determined to refine Hays's and Cotton's long-reach canal scheme along the level terrain of the Mediterranean coast and bring fresh water into the Negev.

By 1964, when the first fresh water was tapped from the Sea of Galilee and transported via a complicated system of dikes, tunnels, and pipelines to the arid Negev, Tel Aviv could at last claim that superior technology, combined with dogged determination, would make the desert bloom again. The completed project, however, created new concerns. The project sent political shock waves through Israel's neighbors. The first Arab Summit meeting in Cairo in 1964 placed a scheme for upstream diversion of Sea of Galilee and Jordan River tributary waters on its agenda but failed to act. Other questions concerning new development prospects arose. Some of these came not from engineers' notebooks, but from accumulated documentation from archaeologists, agronomists, and mineralogists studying both the natural ecological and settled agricultural history of the Negev region.

SIGNIFICANCE

Since the water that came within reach of the thirsty Negev in 1964 was very limited in volume, priorities were set to use the water as effectively as possible. First, an important element of the Hays Plan would be abandoned: The southern Negev zone was not scheduled to receive imported water. At the same time, plans for use of scarce piped-in water for agricultural development per se had to take second or third priority in what came to be known as Israel's Northern Negev Master Plan, first published in 1966.

Although the Northern Negev Master Plan did not concern itself specifically with the original body of archaeological evidence that had been collected beginning in 1936, it was apparent that much could be learned about the productive potential of the Negev Desert by examining traces left there by much earlier populations. Even more important than restricting areas for agricultural use of water was the Northern Negev Master Plan's concern that economic development potential would encourage concentrated population centers. Attracting Israeli settlers to planned towns and cities would necessitate planning for careful use of imported water to sustain such population centers.

Thus, archaeological studies of ancient sites that had supported human communities in antiquity provided guidelines for adopting technological strategies to repopulate the Negev in the most ecologically efficient way possible in the twentieth century. Perhaps the key task for archaeologists was to find traces of early sites where rudimentary methods of collecting surface moisture in the form of dew-like condensation had provided at least enough water to feed home cisterns, and possibly some surplus moisture for very careful gardening. Generally speaking, the zones that would eventually be identified in the 1966 master plan as suitable for small Israeli villages would be located in areas where such archaeological evidence was promising enough to risk strictly controlled colonial rivals.

Combined archaeological and mining resource explorations made it possible to calculate whether remaining mineral deposits near the sites of larger ancient towns were significant enough to base the local economy of full-sized Israeli towns on extractive industries. In cases where evidence was encouraging, bigger settlements were

planned, with the assumption that a steady pattern of economic development would justify spending more money on technology to bring more water to communities with little agricultural development potential.

Byron D. Cannon

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■ FEBRUARY 5, 1967

TANZANIA'S NYERERE OUTLINES SOCIALIST FARMING POLICY

In his Arusha Declaration, Tanzanian president Julius Nyerere articulated a socialist state based on self-reliance, equality, and national economic development and industrialization using Tanzania's own resources. Although Nyerere's African socialism, which also included a rural community development program called ujamaa, ultimately failed, Tanzania's people became united and thus avoided the ethnic divisions and other disasters that plagued the neighboring regions of the African continent.

ALSO KNOWN AS: Azimio la Arusha

LOCALE: Arusha, Tanzania

AGRICULTURAL ISSUES: Agrarian reform; Agricultural education; Collectivization; Government policy and regulation; Subsistence agriculture; Tropical produce

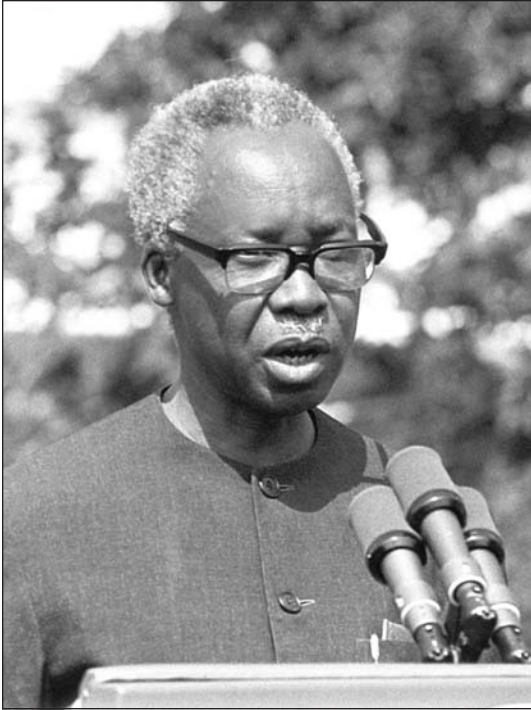
KEY FIGURE

Julius Nyerere (1922-1999), president of Tanzania, 1964-1985

SUMMARY OF EVENT

On January 29, 1967, the United Republic of Tanzania, which had been independent of British trusteeship since December 9, 1961, proclaimed its commitment to socialism and self-reliance enshrined in the Arusha Declaration (Azimio la Arusha). The declaration officially was published on February 5. The author of this document, Tanzanian president Julius Nyerere, was the founder of the Tanganyika African National Union (TANU; later renamed Tanzania African National Union), the nationalist political organization of colonial Tanganyika (1954), and the first president of independent Tanzania. Nyerere envisioned socialism more as an attitude of mind than a well-defined political system, and it involved equality but also self-reliance on the part of every citizen.

Two years before independence, Nyerere had preached the significance of *uhuru na kazi* (freedom and work). After *uhuru* was reached



Tanzanian president Julius Nyerere in later years.
(Library of Congress)

in 1961, Nyerere resigned as the prime minister of independent Tanganyika in January, 1962, and began a massive drive for promoting *kazi*, which was redefined as “self-reliance.” As early as 1959 the World Bank had produced a report on the region’s development problems and potentials. One of its major recommendations was to modernize Tanganyika’s traditional farming methods by making more productive use of the land without depleting its fertility and thereby encouraging capital investment in agriculture. Acting on this recommendation, Nyerere embarked on a village settlement program in 1962, but the program failed dismally. In 1964, he appointed the Village Settlement Commission, which launched its Five-Year Plan (1964-1969) to revamp and carry out the failed venture of 1962. The commission succeeded in setting up five settlements, but, reportedly, the peasants who settled on the schemes had failed to become responsible and self-reliant.

The government, however, did not give up. President Nyerere spent the beginning months of 1967 touring rural Tanzania (Tan-

ganyika and Zanzibar had united in 1964 to form Tanzania). By this time, the five-year-plan period was almost half over. Recurrent expenditures had gone up at an annual rate of 13 percent—well in excess of the 6 percent planned rate—while investment proceeded at 65 percent of the planned rate. Government corporations made investment only one-third of the planned level. Between 1962 and 1966, employment declined and per capita purchasing power in the rural areas did not register even a 5 percent rise above the preindependence level. Even though Tanzania's major crop sisal showed a declining output, cotton and coffee production maintained a steady growth.

Meanwhile, in October, 1966, the government had made it obligatory for graduating university students to enter national service for two years in exchange for their government scholarships. This measure provoked protests from the students, who felt the emoluments attached to the service inadequate; the government retaliated by expelling them from the university. Fearing the growth of a new educated and ambitious bourgeoisie, the president implemented a drastic cut in the salaries and perquisites of all government employees, including the president himself.

Independent Tanzania's problems as perceived by Nyerere were those of a postcolonial society that had spawned a class of Western-educated bureaucratic elites. As early as 1963, Nyerere had publicly declared his commitment to "a philosophy of African socialism," predicated on "the principle of human equality," and he was determined "to prevent the growth of a class structure" in Tanzania. However, his dilemma until 1966 was that the educated elites, whose oligarchic tendencies he sought to control, were also the means for promoting equality in society. A solution to this predicament was his articulation of a socialist ideology in the TANU with a view to providing a blueprint for his projected Tanzanian polity. This blueprint became the Arusha Declaration of 1967.

This five-part document proclaimed Tanzania a socialist state, providing equal rights and opportunities to its citizens, state ownership and control of the means of production, and good leadership. The declaration highlighted its most important agenda in its third part, titled "The Policy of Self-Reliance," which enjoined Tanzanian peoples to harness their energies and efforts to use the nation's own re-

sources for development. It was a call for self-respect and a new paradigm of development without foreign aid and industrialization. The novelty of this paradigm consisted in its recognition of the history, culture, and geography of Tanzania.

The Arusha Declaration was followed in March, 1967, by a program of self-help education based solely on Nyerere's directive, "Edu-

ARUSHA DECLARATION

Julius Nyerere, founder of the Tanganyika African National Union (TANU) and president of Tanzania, issued the Arusha Declaration, which proclaimed the country's commitment to socialism and self-reliance:

(a) The Leadership

1. Every TANU and Government leader must be either a peasant or a worker, and should in no way be associated with the practices of capitalism or feudalism.
2. No TANU or Government leader should hold shares in any company.
3. No TANU or Government leader should hold directorships in any privately owned enterprise.
4. No TANU or Government leader should receive two or more salaries.
5. No TANU or Government leader should own houses which he rents to others. . . .

(b) The Government and Other Institutions

1. Congratulates the Government for the steps it has taken so far in the implementation of the policy of socialism
3. Calls upon the Government to put emphasis, when preparing its development plans, on the ability of this country to implement the plans rather than depending on foreign loans and grants as has been done in the current Five-Year Development Plan. The National Executive Committee also resolves that the Plan should be amended so as to make it fit in with the policy of self-reliance.
4. Calls upon the Government to take action designed to ensure that the incomes of workers in the private sector are not very different from the incomes of workers in the public sector.
5. Calls upon the Government to put great emphasis on actions which will raise the standard of living of the peasants, and the rural community. . . .

cation for Self-Reliance.” This program was to help the majority of the population complete primary education and enter a farming career. Kiswahili was to be the medium of instruction in rural schools, each of which was to have a farm.

Nyerere’s other major policy declaration, “Socialism and Rural Development,” was issued in September of 1967. His vision of socialism was predicated on the African concept of familyhood or extended family, a concept represented by the Kiswahili word *ujamaa* and aimed at fostering self-help by following three principal tenets: recognition of mutual involvement, communal ownership of property, and a personal commitment to work. Though never explicitly mentioned in the text of the Arusha Declaration, *ujamaa* was launched by organizing ideal rural communities having equal access to education and medical facilities for the inhabitants to practice collective farming on the Chinese model. *Ujamaa* was intended to preempt the formation of a class system (employers and workers) by developing “rural economic and social communities where people live together and work together for the good of all.” This collectivization program involved nearly ten million Tanzanians.

Unfortunately, Nyerere’s sincere and well-intentioned socialist project ran into trouble during the late 1970’s, and the Tanzanian economy was in shambles. The goal of attaining self-reliance was never realized, and the country continued to depend on foreign aid. The *ujamaa* villages turned out to be instruments of state control of agriculture, the benefits of which went into the pockets of the bureaucrats. Consequently, production suffered and numerous peasants (the so-called uncaptured peasantry) found ways and means to abandon their village communes and set up their own subsistence-farming practices. The economic crisis worsened with the rapid decline in exports and the country’s inability to import the basic consumer goods. By 1977-1978, the collectivization program had come to an end.

Unable to meet its debt obligations, the government of Tanzania was forced to abandon its socialist policies at the insistence of the World Bank and the International Monetary Fund. This situation was exacerbated by the global oil crisis of the early part of the decade and by Tanzania’s declaration of war in 1978 against neighboring Uganda, then under the violent dictatorial regime of Idi Amin.

Though Tanzania won in April, 1979, it was a Pyrrhic victory, as the country's military expenses stood at the rate of U.S. \$1 million per diem for more than twelve months. In his farewell speech on November 5, 1985, the day he resigned, President Nyerere acknowledged the shortcomings of his *ujamaa* policies.

SIGNIFICANCE

Doubtless the *ujamaa* program proved to be more utopian than utilitarian. Nevertheless, it resulted in raising the country's health and education standards. Also, Nyerere's judicious implementation of Kiswahili as Tanzania's national language and his one-party state (Chama cha Mapinduzi, formed in 1977 by merging TANU with the Afro-Shirazi Party of Zanzibar) went far in unifying his country and thus avoiding ethnic divisions and disasters that plagued the neighboring regions of the continent.

Narasingha P. Sil

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■ JUNE, 1967

SCIENTISTS DEBATE USING ANTIBIOTICS IN ANIMAL FEED

A symposium held by the National Academy of Sciences initiated American debate concerning the relationship between antibiotics in animal feed and antibiotic resistance in humans.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Animal husbandry; Diet, nutrition, and cuisine Disease and health issues; Scientific research

KEY FIGURES

Thomas H. Jukes (1906-1999), director of nutrition and physiology research at Lederle Laboratories, who in 1949 found a connection between antibiotics and animal weight gain

Tsutomu Watanabe (fl. mid-twentieth century), microbiologist at the Keio University School of Medicine in Japan, who proved that drug resistance could be transferred

Donald Kennedy (b. 1931), Food and Drug Administration commissioner, who attempted to regulate the unrestricted use of penicillin and tetracycline in animal feed

Scott D. Holmberg (fl. mid-twentieth century), scientist at the Centers for Disease Control, who established a link between the use of antibiotics in cattle feed and human illness

Thomas O'Brien (b. 1929), director of the microbiology laboratory at Brigham and Women's Hospital in Boston, who found that resistance plasmids from animals and humans shared identical DNA fingerprints

Richard Novick (b. 1932), director of the Public Health Research Institute of the City University of New York, who found that antibiotic-resistant bacteria are freely transmitted from animals to humans

SUMMARY OF EVENT

Antibiotics have been used as animal feed additives since the 1950's, although there were indications from the start that such additives

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might contribute to the development of antibiotic-resistant bacteria. Many scientists considered the public health risk of the practice unacceptable and recommended that it be regulated.

In June, 1967, the National Research Council of the National Academy of Sciences held an international symposium at the request of the U.S. Food and Drug Administration (FDA) to address growing concerns about the link between the practice of feeding antibiotics to livestock and the development of antibiotic-resistant human pathogens, or disease-producing organisms. Although most participants in the symposium agreed that the addition of antibiotics to feed improved the quality of the meat produced, there was no consensus as to the risks to humans from traces of antibiotics in foods. Two areas of public health that concerned scientists were the emergence of more antibiotic-resistant pathogenic bacteria and adverse allergic reactions in individuals sensitive to particular antibiotics.

In 1949, Thomas H. Jukes, director of nutrition and physiology research at Lederle Laboratories, found that *Streptomyces aureofaciens*, the bacterium that produces the antibiotic chlortetracycline (Aureomycin), also produced high concentrations of vitamin B₁₂. Because



Cattle feeding in a severely crowded pen in Arizona. (Getty Images)

animal feeds used at that time were vitamin B₁₂-deficient, Jukes thought that the fermentation wastes from the production of chlortetracycline might be a good, inexpensive feed supplement. To his surprise, the chicks and piglets that received the supplement gained significantly more weight than animals fed vitamin B₁₂ from other sources. The weight gains were especially significant among animals that were at risk from bacterial infections or from the stress of overcrowding. Jukes found that although more antibiotic-resistant bacteria were found in treated animals than in untreated ones, the treated animals continued to gain weight and could be fed less. Scientists suspected that maintaining the animals from birth on low concentrations of antibiotics prevented mild, nonsymptomatic diseases and infections that might have been slowing growth, and they assumed that because the animals grew bigger, they were healthier.

Using antibiotics in livestock feed, which became common practice during the 1950's, created major changes in the way meat is produced. Meat growers could produce larger animals on less food. Even more important from an economic point of view, producers could keep animals in more crowded surroundings, because the likelihood of infectious diseases spreading was diminished. As large-scale production on less land became possible and profitable, small farms where the flocks or herds ranged in large yards or pastures disappeared.

When antibiotics are fed to animals for extended periods of time, there is increased likelihood that antibiotic residues will remain in the meat. It was legal to use chlortetracycline up to the day of slaughter; when tetracycline was combined with other antibacterial drugs, however, the mixture had to be withdrawn fifteen days before slaughter. Even then, it was possible that antibiotic residues or antibiotic-resistant bacteria remained in the meat.

Already during the 1950's, some scientists were alarmed at the increase of antibiotic-resistant bacteria they observed in the human population. Initially, they believed that overuse of antibiotics in human medicine was the primary reason for the growing resistance. By the 1960's, however, scientists and clinicians increasingly came to suspect that a contributing factor might be the practice of lacing livestock feed with subtherapeutic doses of antibiotics; subtherapeutic doses are defined as concentrations too low to be effective in treating a disease.

The practice of feeding antibiotics to livestock has two significant consequences. First, antibiotic residues in the meat may contribute to the selection of antibiotic-resistant bacteria in the intestinal tracts of human consumers. Second, resistant bacteria from the animals may transfer their resistance to both pathogenic and nonpathogenic bacteria in humans. Bacteria that become resistant to many antibiotics are a particularly serious problem in the treatment of infectious diseases. Japanese microbiologist Tsutomu Watanabe found that the genes for resistance to antibiotics are often found on small circular pieces of deoxyribonucleic acid (DNA) called plasmids. Plasmids are separate from the main chromosomes of the bacteria and can easily be transferred from one bacterium to another during a process called conjugation. Conjugation is one of the ways that bacteria transfer genes to one another to introduce genetic diversity (and hence adaptability) into a population. Thus, one antibiotic-resistant cell in a population can very quickly convert the entire population to resistance. Plasmids may also contain transposons, DNA sequences that direct the genes adjacent to them to “jump” from one place to another. By this mechanism, a plasmid that already carries the gene for penicillin resistance may acquire an additional gene for tetracycline resistance. Because transposons can mediate the transfer of multiple genes, plasmids that gain two or more antibiotic-resistant genes can be created.

SIGNIFICANCE

After the discovery of penicillin by Sir Alexander Fleming in 1928, medicine came to rely on antibiotics to treat bacterial infections of all kinds. Many of the diseases caused by bacteria were life-threatening before the availability of antibiotics. As more bacteria become antibiotic-resistant, however, many strategies used throughout the twentieth century for treating diseases were no longer successful. Scientists continued to discover new, effective antibiotics, but new resistant bacterial strains continued to emerge as well.

After an outbreak of antibiotic-resistant infectious diarrhea caused by salmonellae in Great Britain during the mid-1960's, which began in cattle and spread to humans, the British government appointed a group of scientists to study the problem. The Swann Committee report, issued in 1969, concluded that the subtherapeutic use

of antibiotics in animal feed posed a significant health risk to humans and should be restricted. As a result of the Swann Committee's report, the FDA appointed a task force to study the problem in the United States. There, the greatest concern was for two forms of tetracycline, chlortetracycline and oxytetracycline, and penicillin because of their effectiveness in the treatment of many human diseases. Scientists feared that substantial increases in the numbers of tetracycline- or penicillin-resistant bacteria would have a major adverse effect on public health.

In 1972, the FDA threatened to ban subtherapeutic use of antibacterial agents in animal feed unless the feed-, antibiotic-, and meat-producing industries could show that the agents were safe. In 1977, Donald Kennedy, then FDA commissioner, decided that there was insufficient evidence to conclude that antibiotics were safe and proposed a ban of all subtherapeutic uses of penicillin in feed and most subtherapeutic uses of tetracycline. The Senate and House Committees on Appropriations, however, instructed the FDA to conduct additional studies on the issue of safety. A report issued in 1980 by the National Academy of Sciences (NAS) found that the studies existing at that time were all flawed in one way or another. The NAS report indicated that there was not much direct evidence to substantiate a connection between antibiotic residues in meat and resulting antibiotic-resistant bacteria in humans, but it did recommend further studies. A bill to require the FDA to regulate antibiotic use in feeds was proposed in the House in 1980 by John D. Dingell and Henry Waxman, but the bill died in committee.

Eleven years after its original proposal to restrict the use of penicillin and tetracycline in animal feeds, the FDA proposed allowing new animal feed uses of penicillin and tetracycline, though it also acknowledged that there was strong evidence of a connection between use of antibiotics in feed and antibiotic resistance. The Natural Resources Defense Council (NRDC), a nonprofit, environmental law firm, drafted a petition in 1983 signed by approximately three hundred scientists, which urged President Ronald Reagan and the secretary of health and human services to ban the subtherapeutic use of penicillin and tetracycline in livestock feed. Al Gore, then a congressman, held more hearings on the topic in 1984. That same year, the NRDC filed a petition of "imminent hazard"

with the FDA, and again hearings were held, but the petition was rejected in 1985 by Secretary of Health and Human Services Margaret Heckler, upon recommendation of FDA Commissioner Frank E. Young.

Among the studies of possible links between antibiotic residues in meat and public health risks was one by a team of scientists from the Centers for Disease Control in Atlanta headed by Scott D. Holmberg, which studied outbreaks of salmonellosis caused by antibiotic-resistant salmonellae bacteria in the United States between 1971 and 1983. The study showed that animal-to-human transmission of resistant bacteria occurred in a significant portion of the cases and that the fatality rate was higher in infections with resistant bacteria than in those with antibiotic-sensitive salmonellae. In another study, Thomas O'Brien, director of the microbiology laboratory at Brigham and Women's Hospital in Boston, compared the DNA fingerprint from resistance plasmids suspected of having been transmitted from animals to humans. By using enzymes that split DNA only at certain of its building-block sequences, scientists could produce patterns, or fingerprints, unique to it. O'Brien found that the resistance plasmids from salmonellae bacteria taken from animals and people throughout the United States often had nearly identical fingerprints. Using the same technique, Richard Novick and his associates at the Public Health Research Institute in New York and the College of Veterinary Medicine at Cornell University found that DNA sequences on resistance plasmids from staphylococcus and streptococcus bacteria in pigs and pig handlers were nearly identical. Studies such as these suggested that transmission from animals to humans was occurring frequently and easily.

The use of antibiotics in feed continued to be controversial, particularly as the situation was further complicated by factors such as the overprescription of antibiotics in the treatment of human diseases, the extent to which bacteria obtained through food become resident in humans, and the effects of using the same antibiotics both in feed and in the treatment of livestock diseases. It remained unclear whether discontinuing the use of low doses of antibiotics in livestock feed would affect the numbers of antibiotic-resistant bacteria circulating in the human population.

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■ JULY 1, 1967

EUROPEAN ECONOMIC COMMUNITY ADOPTS COMMON AGRICULTURAL POLICY

The Common Agricultural Policy was adopted to guarantee price subsidies and favorable international competitive conditions for all European Economic Community farmers.

ALSO KNOWN AS: CAP

LOCALE: Brussels, Belgium

Agricultural issues: International food relief; Marketing and trade;
Price supports and controls

KEY FIGURES

Sicco Mansholt (1908-1995), Dutch politician and EEC commissioner for agriculture

Jean Monnet (1888-1979), French businessman and head of the Commissariat Général du Plan

Charles de Gaulle (1890-1970), head of the French provisional government, 1944-1946, and president of France, 1959-1969

SUMMARY OF EVENT

In 1967, the European Economic Community (EEC) launched the comprehensive Common Agricultural Policy (CAP), the main goal of which was to create a large, intra-European agricultural market with common prices, external tariffs, and a financial structure to cover its costs. Although the CAP succeeded in achieving, indeed surpassing, Common Market agricultural self-sufficiency, one of its results has been higher food prices than in the rest of the world and a consistent pattern of European agricultural protectionism.

Negotiations for the Common Agricultural Policy started soon after the six Common Market founders—West Germany, France, Italy, Belgium, the Netherlands, and Luxembourg—signed the Treaty of Rome in 1957. The treaty signaled the six countries' common intention to build an economic community comprising a growing number

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Vineyards in southern France's fertile Midi region. (©David Hughes/Dreamstime.com)

of sectors, including agriculture. The task was to extend the work of Jean Monnet, the father of the European Coal and Steel Community in 1950; that is, it was to fulfill the French businessman's dream of a Europe consisting of large, ever-growing, and diversified markets. In such a world, war would be unthinkable. This was particularly true in the case of Franco-German economic integration: French farmers were more efficient than their German counterparts, especially in grain production; West Germans, however, surpassed the French in several industrial sectors. France, as a consequence, sought to establish common agricultural prices higher than France's and lower than Germany's. In 1962, French president Charles de Gaulle pressed for the establishment of a policy to achieve that goal. In exchange for the advantages granted to French farmers, West German access to French industrial markets would be facilitated.

Article 39 of the Treaty of Rome covered EEC goals with regard to agricultural policy. The community would seek to create stable mar-

kets with regular supplies and fair prices, while promoting an increase in agricultural efficiency and in farmers' standards of living. The community set out to achieve these goals through a liberalization of intra-European trade, exposing farmers to competition from their European neighbors but protecting them from competition from their extra-European counterparts. Achieving such goals meant transforming the Community's agricultural sector completely. When the Treaty of Rome was signed, the EEC's agricultural sector was still labor intensive and technologically backward. It provided the farming population, frequently employed in inefficiently small farm units, with a low standard of living. The CAP thus also meant modernization.

As far as the agricultural sector was concerned, Monnet's dream of European economic integration was put in the hands of a Dutchman, Sicco Mansholt, the Community's first commissioner for agriculture. Mansholt drew up plans to implement the directives of Article 39 and led the process of agricultural price negotiation among the Community's members between 1962 and 1967. His efforts were directed toward eliminating existing national systems of support for farmers and replacing them with an integrated support system based on common prices.

Mansholt's task was not an easy one. When negotiating a common price, there was always the danger of damaging the relative competitive positions of farmers in one or more of the six countries. For all of their vaunted will to integrate, Community members feared the very liberalization of intra-European trade that was the EEC's *raison d'être*. Political parties that drew support from agricultural voters feared losses at the polls whenever they accepted price compromises. Agreements were reached only after several crises in the process of integration. By 1961, there were general policy agreements concerning eggs, pork, poultry, and grains, but no definitive price system. By 1963, in the course of a marathon meeting, agreement was reached on the prices of milk and dairy products, beef and veal, rice, and fats.

At a similarly difficult session in 1964, the six Community members agreed on a most important price, that of grain. Grain affected several other agricultural sectors, such as pork and beef. By 1967, the price agreements covered 90 percent of all farm output in the EEC and approximately ten thousand workers in the agricultural sector.

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By and large, agreements were reached by establishing high prices that sheltered the least efficient and weakest competitors in the community. The EEC set out to maintain the high prices by effecting massive purchases of agricultural products whose supply exceeded demand. The goods thus purchased would either be stored for future sale, when demand increased, or sold at a loss outside the Community.

The commodity purchase feature of the CAP necessitated creation of reliable financial institutions. The first of these was the European Agricultural Guidance and Guarantee Fund (EAGGF), created in 1962. The fund's capital would be supplied by the member countries, which committed themselves to deposit, in ever-increasing proportions, the proceeds of levies and customs duties on imports of foodstuffs. Later, the EEC's financial needs increased to such an extent that 100 percent of all levies (by 1971) and 100 percent of all customs duties (by 1975) would be turned over to the community by member states. By 1975, the EEC pooled all levies and customs duties and harmonized value-added taxes. Thus, by the mid-1970's, the CAP's financial resources were in place, subsumed within an increasingly complex and vast financial system.

SIGNIFICANCE

Negotiations for the establishment of common agricultural prices did not yield the structural reform foreseen in Article 39 of the Treaty of Rome. What was done by July 1, 1967, was almost immediately considered insufficient to meet the Community's ambitious integration targets. As a consequence, Mansholt immediately set out to draw up new plans in order to improve on the 1967 CAP. By 1968, Mansholt had issued a new plan.

Mansholt pointed out that the CAP should encourage structural reform without creating excessive hardship for the farming population. The new plan called for increasing the size of farming units while decreasing the overall acreage under cultivation and encouraging occupational shifts away from the countryside toward industry. Such a reform, which promised to displace smaller family farms everywhere within the Community, would be accompanied by increased prices and further guarantees that extra-community products would be sold at the high EEC price levels. The community

AVERAGE FARM SIZES IN COUNTRIES OF THE EUROPEAN UNION

<i>Country</i>	<i>Average Farm Size</i>	
	<i>Acres</i>	<i>Hectares</i>
Belgium	42.0	17.0
Denmark	80.3	32.5
France	75.9	30.7
Germany	42.0	17.0
Greece	15.5	5.3
Ireland	56.1	22.7
Italy	19.0	7.7
Luxembourg	82.0	33.2
Netherlands	42.0	17.0
Portugal	20.5	8.3
Spain	42.0	17.0
United Kingdom	170.0	68.9

would intervene to maintain the high prices whenever necessary.

Despite such guarantees, EEC farmers almost unanimously opposed Mansholt's new plan, as their way of life and livelihood both appeared threatened. Moreover, the interests of consumers had not been taken into due account: High agricultural prices would certainly mean a lower standard of living for nonagricultural workers. As a consequence, attempts at structural reform were considerably watered down, and the modified CAP of 1968 still did not address some of the community's

fundamental problems. In fact, the high prices guaranteed by the EEC simply encouraged overproduction and yielded large surpluses, which the EEC had pledged to buy. By the early 1970's, critics ridiculed the community's "mountains of grain" and "olive oil lakes." Almost all EAGGF funds were expended to maintain the high price targets set by the EEC. The general results were little success in increasing the size of farms and EEC prices between two and five times as high as world market prices. A protectionist vicious circle had set in: Protected farmers could afford to avoid structural reform and thus encouraged the perpetuation of an inefficient system.

Paradoxically, the only sectors consistently forced to make structural adjustments were the food-processing industries. These were affected by the CAP's harmonization of member states' laws concerning the processing, packaging, grading, and labeling of almost all foodstuffs. The integrated legislation became increasingly complex over the years and required businesses to expend large amounts of capital in order to adapt to and comply with CAP regulations. Discontent on the food-processing industries' part was not lacking.

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For their part, consumers, who were generally otherwise highly taxed, paid excessive prices for their food; at the same time, potential extra-community competitors, especially from the United States, were cut off from European markets. To nobody's surprise, the United States persistently attacked the CAP, which constituted a major stumbling block in the path toward a European-American agreement in the ambit of the General Agreement on Tariffs and Trade (GATT).

Another problem that surfaced over the years regarded the relative value of the community countries' currencies. The common agricultural prices had been set by using a common accounting unit with a gold content equal to that of the U.S. dollar. It was assumed that the value of the EEC countries' currencies would be maintained at the same levels; the possibility of monetary fluctuations was not fully taken into account. When such fluctuations did occur, it became apparent that the CAP, as originally designed, would largely fail in its intent to harmonize agricultural prices in EEC countries. If a country devalued its currency, that country's farm prices would rise domestically but fall relative to those in the rest of the community.

Each time a devaluation occurred, it required complex agricultural price readjustments; these, however, could not offset the clearly intra-community protectionist aspect of the devaluation itself. Changes in the value of member countries' currencies, therefore, tended to defeat the purpose of the CAP, which was to create a uniform EEC agricultural market.

Despite all the above-mentioned problems, the Common Agricultural Policy became one of the EEC's "sacred cows," not least because

THE PRICE OF CENTURIES OF CULTIVATION

German authorities have estimated that because the European landscape has been exploited by humans for so many centuries, fourteen plant species totally disappeared between 1870 and 1950, and 130 more species disappeared from 1950 to 1980. Fifty more species are threatened or endangered. Intensive agricultural development of the land is largely responsible, stimulated by an agricultural price support system that encourages growth of agriculture.

it was one of the few truly centralized and indeed common policies of the EEC. Despite the CAP's many problems, the community's population working on farms did decrease to 6 percent during the 1980's from about 20 percent in 1960, while the amount of land under cultivation was reduced from 175 to 160 million acres. At the same time, the standard of living of the remaining farming population definitely increased, as did levels of mechanization. The CAP thus yielded mixed results, with a more negative appraisal in order when considering overall performance rather than the well-being of the farming population.

Chiarella Esposito

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■ 1968-1973

DROUGHT EXTENDS THE REACH OF THE SAHARA DESERT

Intense population pressure, large-scale climatic change, and poor land management not only brought considerable hardship to residents of the Sahel region of northern Africa but also extended the size of the Sahara Desert and nearly ruined the economies of sixteen countries, causing widespread famine and emigration.

LOCALE: The Sahel, North Africa

AGRICULTURAL ISSUES: Cattle keeping; Drought; Ecology and environment; Famine and hunger; International food relief; Migration; Natural disasters; Population growth

KEY FIGURES

Sangoulé Lamizana (1916-2005), president of Upper Volta

Léopold Senghor (1906-2001), politician, poet, and president of Senegal

SUMMARY OF EVENT

Between 1968 and 1973, the Sahel region suffered a drought that led to the expansion of the Sahara Desert. The rate of expansion—more than twenty million hectares each year—was extraordinary, as it transformed the once-green southern savanna into desert. Though the drought was temporary, its ecological and economic effects on the sixteen countries of the Sahel have been profound and lasting.

The Sahel (derived from the Arabic *sahil*, meaning “a shore”) is a zone in sub-Saharan Africa where the yearly precipitation is low and the evaporation intense. Some climatologists identify the region by a range of yearly precipitation from 100 millimeters (3.9 inches) in the north to 600 millimeters (23.5 inches) in the south, but most believe that the ratio between precipitation and potential evapotranspiration (the amount of water that could evaporate from a plant in a given climate) is a far better indicator to sort areas into deserts or

DESERTIFICATION

Desertification is the extension of desert conditions into new areas. Typically, this term refers to the expansion of deserts into adjacent nondesert areas, but it can also refer to the creation of a new desert. Land that is susceptible to prolonged drought is always in danger of losing its vegetative ground cover, thereby exposing its soil to wind. The wind carries away the smaller silt particles and leaves behind the larger sand particles, stripping the land of its fertility. This naturally occurring process is assisted in many areas by overgrazing.

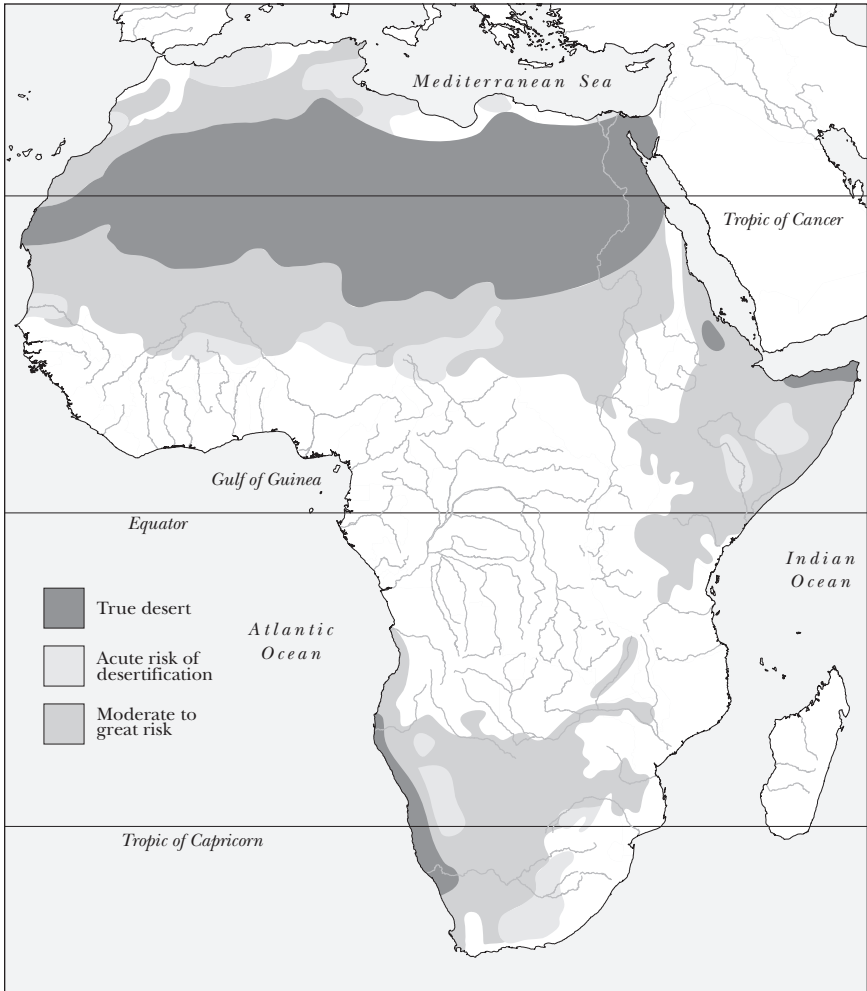
In the African Sahel, south of the Sahara, the impact of desertification is acute. Recurring drought has reduced the vegetation available for cattle, but the need for cattle remains high to feed populations that continue to grow. The cattle eat the grass, the soil is exposed, and the area becomes less fertile and less able to support the population. The desert slowly encroaches, and the people must either move or die.

semideserts. In the Sahel, most of the precipitation falls in the summer (June to September), when the temperature is the highest; plants therefore require more water to remain alive and well.

The Sahel is by this latter definition a semidesert. It would be erroneous, however, to believe that the climatic and social catastrophes that affected the region between 1968 and 1973 were solely the products of drought unbalancing a tenuous equilibrium between plant life and the environment. During the twentieth century, droughts affected the area several times (1910-1916, possibly 1912-1920, 1940 or 1944-1948, 1968-1973, 1980-1984), but none had the same devastating effects of the 1968-1973 drought. The cumulative effects of the droughts of the century have changed the patterns of human habitation and resource exploitation.

The Sahel is divided into sixteen independent states. Most of these countries were colonized by European nations during the nineteenth century. One of the benefits of this colonization was the improvement of the health of indigenous populations through better medical care, immunization campaigns, and steady food production, leading to a decrease in the death rates while the birthrates remained steady and high. The consequence was a high population increase of about 3 percent per year. At such a rate, a population can double ev-

DESERTIFICATION OF AFRICA



ery twenty-three years. With such a large number of hungry people, the region saw increased migrations northward, with populations expanding more and more into the sparsely populated Sahel.

Initially, it appeared that the area could absorb the migrating population. The weather during the first seven years of the 1960's was wetter than normal, and the food produced was adequate for the growing population. However, in 1968, the precipitation level fell as much as 40 percent, and the drought began. Benin, Burkina Faso

1968-1973

(Upper Volta), the Cape Verde Islands, Gambia, the Central African Republic, Chad, Ethiopia, Djibouti, Sudan, Nigeria, Niger, Mauritania, Mali, and Senegal suffered immensely.

Traditionally, the migrant populations were herders or farmers, or both. The herders were transhumant; that is, they moved their cattle north during the summer to benefit from the short rainy season and back south during the rest of the year. After the drought began, herds of goats, sheep, camels, and cows overgrazed their pastures, devouring every blade of grass and killing the vegetation. The denuded pastures could not anchor the soil, leading to massive soil erosion. Stronger winds began eroding the topsoil and moving sand dunes at a speed never before observed. The farmers of the region employed traditional agricultural practices in which soil fertility was protected by allowing fields to lie fallow (unused) for several years before replanting. This extensive (rather than intensive) land-use system was compromised when the growing population, and the effects of the drought, forced farmers to continue using their lands season after season, which led to a significant decline in fertility and food production.



Typical desert scene on the northern fringe of the Sahel. (©Eldin Koric/Dreamstime.com)

The people of the Sahel suffered first from lack of food. Images of emaciated people flooded the media. The economies of the countries of the region suffered a staggering decrease in food production, estimated at more than 600,000 tons of grain crops per year, or a 15 percent loss each year of the drought. The sustained drought (and, because of it, the digging of new wells that lowered the water table), the increase in the number of animals overgrazing the remaining pastures, and the exhaustion of overworked agricultural fields combined to create a growing wasteland that was less and less capable of sustaining human populations.

This process of destroying an existing ecosystem and replacing it with a drier, more barren landscape is called desertification. Although there are more than one hundred different definitions of desertification, the signs are consistent. Physically, the signs include disappearance of some plants and their replacement with species better adapted to drought, as well as topsoil depletion. Socially, the signs include malnutrition and famine. Desertification in northern Africa from 1968 to 1973 progressed from north to south, expanding into the Sahel at a rate of more than twenty million hectares per year.

The human disaster that the drought and consequent desertification precipitated was not ignored by the world community. The Organization for Economic Cooperation and Development and the European Economic Community, among other organizations, sent relief supplies to the area. However, local governments recognized that the problem could not be resolved through short-term means. General Sangoulé Lamizana, president of Upper Volta (now Burkina Faso), and Léopold Senghor, president of Senegal, realized that local solutions to a regional problem could not possibly be effective. They worked tirelessly to mobilize the nations of the area to fight the effects of desertification. In 1973, they were instrumental in founding the Comité Permanent Inter-états de Lutte Contre la Sécheresse du Sahel (Inter-States Committee to Fight Drought in the Sahel), or CILSS.

With the group's first president, Lamizana, the nine affected nations of Gambia, Guinea Bissau, Mauritania, Senegal, Mali, Niger, Chad, the Cape Verde Islands, and Upper Volta organized efforts to resolve the ecological and economic problems that threatened their region. The CILSS proved to be useful both for the analysis of the

problem and for implementing potential solutions; it sought to improve farming practices to reduce soil loss, control irrigation, introduce plant crops better adapted to the semiarid environment, and reduce population pressure on an always fragile ecosystem.

SIGNIFICANCE

The severe drought of 1968-1973 brought desertification to an extremely fragile environment. The immediate consequences of the desertification pushed the countries affected into an economic crisis when agricultural production could not meet the needs of a growing population. Insufficient food production led to social tensions that people thought they could resolve by migrating, but they chose to move to already crowded cities in the hope of finding work, and the cities could not offer them work.

The migrants who sought new lands for agricultural or pastoral pursuits in the Sahel brought with them the ancestral farming practices that led them to migrate in the first place. Their techniques were well adapted to a much rainier environment. The migrants depended too much on irrigation that would leach the nutrients from the fragile soil and lower water tables precipitously in periods of drought. Fallowing and crop rotations that had been at the basis of their traditional farming techniques proved to be impossible in the light of the enormous new population pressures. A transhumant form of pastoralism proved unsound as well after overgrazing caused extensive erosion and loss of viable pasture land.

Lessons were learned from the 1968-1973 drought. The process of desertification is now better understood. It remains to be seen, however, if the countries of the region can revise their systems of exploiting and maintaining the fragile ecosystem of the Sahel and still produce a sustainable economy in which massive disaster, both human and environmental, is avoided.

Denyse Lemaire and David Kasserman

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■ AUGUST 18, 1968

CONGRESS PASSES WHOLESOME POULTRY PRODUCTS ACT

The federal Wholesome Poultry Products Act required uniform standards for poultry inspection and extended requirements to establishments such as companies that provide poultry products for vending machines.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Agricultural education; Disease and health issues; Food processing; Government policy and regulation

KEY FIGURES

Orville L. Freeman (1918-2003), U.S. secretary of agriculture, 1961-1969

Lyndon B. Johnson (1908-1973), president of the United States, 1963-1969

SUMMARY OF EVENT

The Wholesome Poultry Products Act, passed on August 18, 1968, stipulates that poultry and poultry products must meet federal inspection standards. Prior to passage of this act, poultry processing plants were regulated by states or not at all. Poultry inspection processes varied among states, resulting in some plants having modern equipment and sanitary conditions and other plants being less well equipped.

The poultry act requires that processors who prepare poultry and producers of foods containing poultry that are transported for sale across a state line must meet federal inspection standards and are under the jurisdiction of the U.S. Department of Agriculture. The U.S. secretary of agriculture at the time of the act's passage was Orville L. Freeman. Establishments that prepare or produce poultry for intra-state transport fall under the jurisdiction of state inspection. This act extended coverage of federal poultry inspection standards to establishments that had not previously been covered and provided a model for establishing inspection programs at the state level.

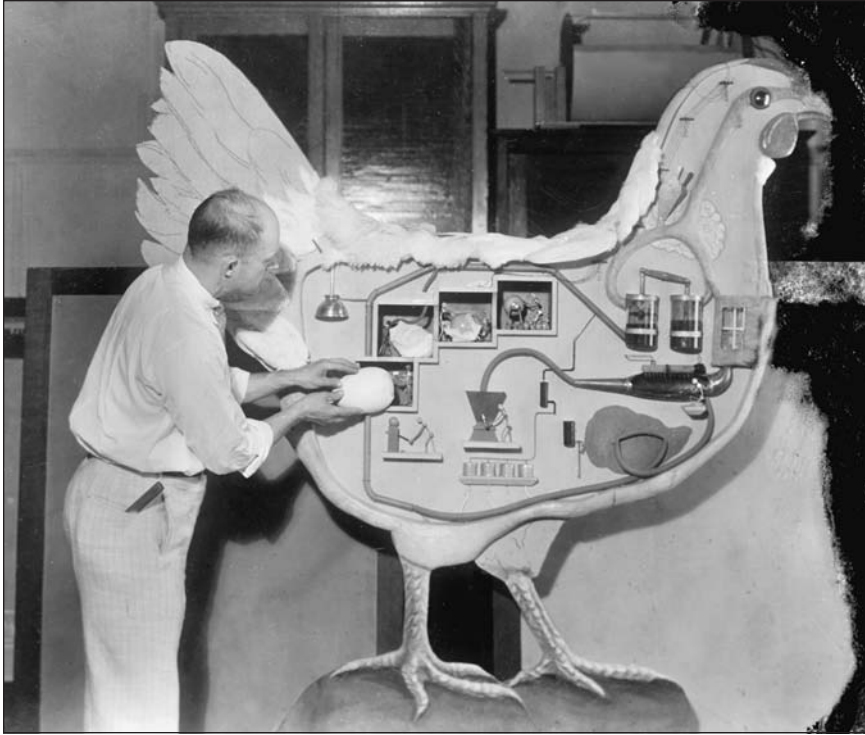
The objective of the act was to ensure uniform inspection across all states in the United States to increase consumer protection. Most poultry and poultry products produced in the United States move across state lines or through foreign commerce, so uniform standards among states are warranted. The act stipulates that

it is essential in the public interest that the health and welfare of consumers be protected by assuring that poultry products distributed to them are wholesome, not adulterated, and properly marked, labeled, and packaged.

The Wholesome Poultry Products Act followed the Wholesome Meat Act, passed in 1967. A consumer rights movement had increased Americans' awareness of potential health and safety risks of meat-based food products. Consumer advocates and President Lyndon B. Johnson publicly supported improvements in inspection standards for food products in the United States. Once the Wholesome Meat Act was passed, the Amalgamated Meat Cutters joined with some members of Congress in requesting the poultry act. The meat cutters acted in part because they did not want to face regulation stricter than that applied to poultry processors. Later, a seafood act was introduced to complete consumer protection from animal foods.

Attention has been given to the safety of the practices of the meat processing industry since publication of Upton Sinclair's novel *The Jungle* (1906). That book alerted consumers to concerns about the safety of meat processing. The first law governing meat inspection, the Federal Meat Inspection Act, was implemented in 1907 as a direct result of Sinclair's book. Criticism of inspection practices of the 1960's may have led consumers to believe that conditions were still similar to those during the early years of the twentieth century. A resurgence in interest in food safety by policy makers led to the 1960's revisions of the meat act and the introduction of related acts, including the Wholesome Poultry Products Act.

Widespread consumer concern about the safety of the meat and poultry products available at supermarkets, commissaries, and delicatessens had the potential to substantially affect consumption. Because of the potential negative impact from consumer uneasiness, it was important to successfully implement the new poultry inspection



Responsibility for inspection of poultry products belonged to the U.S. Department of Agriculture long before the 1968 law was enacted. In 1930, the USDA prepared this mechanical exhibit for the World's Poultry Congress in London to demonstrate how chickens transform what they consume into edible eggs. The exhibit startled visitors by having the mechanical chicken deliver a lecture. (Library of Congress)

standards to restore consumer confidence in poultry products and to avoid substantial losses to producers of poultry and related foods.

Poultry products include, in addition to fresh and frozen whole poultry and poultry pieces, canned and frozen foods containing poultry. The frozen foods industry had expanded by the 1960's to include prepared casseroles, dinners, entrées, hors d'oeuvres, pizzas, potpies, and sauces. Also included in the 1968 Wholesome Poultry Products Act, and not previously included in standard inspections, were vending commissaries that prepare poultry products for off-premise sale. A commissary preparing such food items as casseroles, entrées, platters, and salads containing poultry was required to meet federally approved inspection guidelines throughout the facility.

The Fair Packaging and Labeling Act of 1966 was primarily targeted at nonfood items typically sold in grocery stores, but food and beverage packaging was affected by regulations for product weights or measures and manufacturer address requirements on packages. The Wholesome Poultry Products Act in some respects is an extension of the packaging and labeling act. The poultry act requires that packaging be safe and free of contamination and that the poultry products being sold be represented accurately on the packaging. Specifically, labeling must not be false or misleading in terms of the origin of the poultry product, the quantity of the poultry product, or any additional ingredients to poultry offered in the package. Ingredients must be listed in order of quantity. Additionally, poultry packaging must disclose the name and address of the manufacturer, packer, or distributor. All required information must be placed on the package in a prominent place where the consumer is likely to read it.

The inherent nature of poultry is such that bacteria are easily bred when processing conditions are less than optimal. Under the act, inspections must be set up to detect disease or other types of contamination in poultry. When poultry products are condemned because of contamination or disease, the specific reason for condemnation must be scientifically presented. The act states that adulterated poultry, which cannot be legally sold, is defined as containing additives that are unsafe as defined by the Federal Food, Drug, and Cosmetic Act; containing any poisonous substances; consisting of decomposed, unhealthful, or unwholesome substances; or having been exposed to radiation. Further, poultry processed under unsanitary conditions that may cause contamination is considered to be adulterated.

To reduce the chance of adulteration to poultry, federal standards were mandated for buildings that house meat and poultry packers, including preparers of frozen foods containing meats and poultry. The standards include specifications for plumbing and sewers, water quality, water temperatures, detergents for washing utensils, ceiling and floor surfaces, room sizes, lighting, and worker uniforms. These specifications were created primarily to increase the cleanliness of processing plants.

The U.S. secretary of agriculture, or a delegate, is authorized to

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enforce the Wholesome Poultry Products Act. As a result of the act, the Consumer Marketing Service of the U.S. Department of Agriculture provided training programs for state inspectors so that they would become familiar with federal standards and be able to implement uniform inspections. Each state was given two years after passage of the act to establish inspection programs. An additional one-year grace period could be granted to states making progress toward implementation. Penalties for noncompliance include an exclusion of the state from interstate commerce of poultry and poultry products as well as monetary fines.

SIGNIFICANCE

In response to the inclusion of commissaries under the jurisdiction of the Wholesome Meat Act of 1967, the National Automatic Merchandising Association formed a Meat Inspection Committee. This committee worked with state agencies and the Department of Agriculture to establish standard guidelines that would logically apply to commissaries, which differ substantially from slaughterhouses. The Meat Inspection Committee continued to work as the Wholesome Poultry Products Act was implemented.

Because most consumers in the United States obtain their poultry and poultry products from supermarkets or other retail establishments, the Wholesome Poultry Products Act of 1968 affects the purchasing confidence of many people. Exempted from the act are people who raise and slaughter poultry exclusively for their own use or who custom slaughter for people who have delivered poultry and will retrieve it for their own use. It would be virtually impossible to routinely inspect all small slaughterhouses such as these. Because inspections are not required and standards equal to those for commercial distribution need not be met, there is a greater chance that poultry processed in these slaughterhouses will not be safe.

Labeling requirements are waived for deliveries to certain consumers. For example, wholesale distribution directly to restaurants and hotels for use in their dining rooms is exempted, with the provision that the poultry is sound and healthy. The labeling exemptions eliminate burdens from industries that would not present packaging to the ultimate consumer for examination.

The cost of the poultry act to the federal government is substan-

tial. According to the act, the federal government provides half of the costs for establishing inspection training programs for the states. The states are individually responsible for the other half of training expenses. Traditionally, the federal government has provided inspectors free of cost to plants, a practice that is being continued by states. Although the initial costs of implementation of the act were substantial, the trade-off in consumer confidence has the potential to offset the costs. As a result of the act, consumers are provided with more information about sanitary plant conditions, poultry quality, and specific product contents. This increased confidence in proper information and healthy conditions often leads to increased purchases and feelings of goodwill toward retailers of poultry.

Uniformity among poultry producers, processors, and retailers was expected to be achieved as inspection standards from state to state were homogenized. Implementation, however, proved to be a monumental task. Even though it would appear to be economically beneficial to leave the inspection process to federal representatives, the autonomous nature of states and industries provided motivation for them to become involved in the training of inspectors and the im-



Coops for egg-laying chickens in a modern chicken farm. (©Enrico Jose/Dreamstime.com)

AUGUST 18, 1968

plementation of the act. By the original deadline for state implementation of federally approved poultry inspectors, forty-nine states had been granted a one-year extension, as they were making good progress toward meeting designated standards. North Dakota, the only state not to be given an extension, was notified by the Department of Agriculture that its progress toward an inspection program was not well enough under way, and federal inspectors were given jurisdiction to take over the regulation process there.

In actions related to the Wholesome Poultry Products Act, engineers were hired to redesign plants, plumbing and sewage facilities were updated and improved, and water treatment and purification systems were designed. All these changes have resulted in cleaner plants, safer poultry treatment, and better working conditions in poultry houses.

One of the biggest challenges after enactment of the act was to set into practice the authority of the Department of Agriculture to regulate the conditions of the act. Largely because poultry consumers receive access to information about the origins of the products they purchase, poultry houses were eager to comply with regulations and maintain positive public images. Although inspection processes are not foolproof, there are established practices to be followed by inspectors and plant operators so that safe poultry and poultry products will be delivered to supermarkets and served in commissaries.

Virginia Ann Paulins

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■ NOVEMBER 20, 1969-DECEMBER 31, 1972

DDT BAN SIGNALS NEW ENVIRONMENTAL AWARENESS

By banning the use of the pesticide DDT, or dichloro-diphenyl-trichloroethane, the United States took a first step in addressing environmental concerns relating to many chemical products.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Chemistry; Disease and health issues; Ecology and environment; Pests and pesticides; Scientific research

KEY FIGURES

Rachel Carson (1907-1964), marine biologist and the author of *Silent Spring*

Paul Hermann Müller (1899-1965), inventor of DDT

William Longgood (b. 1917), Pulitzer Prize-winning journalist, author of *The Poisons in Your Food*

SUMMARY OF EVENT

On June 14, 1972, amid considerable controversy, the Environmental Protection Agency (EPA) banned dichloro-diphenyl-trichloroethane (DDT) for use as a pesticide in the United States, a ban that became effective December 31. This followed a ban on use in residential areas issued by the federal government on November 20, 1969. The DDT ban had a far-reaching impact on humanity, the environment, and business. Widespread use of other toxic or dangerous pesticides, however, continued in the United States and elsewhere.

DDT, which consists of chlorinated hydrocarbons or organochlorides, was acquired by the United States from Switzerland in 1942. It was discovered by Paul Hermann Müller, who won a Nobel Prize for the discovery. Prior to the discovery of DDT, there were hundreds of different pesticides in use. Many of these pesticides were effective on only one or a few pests. Some of the more infamous pesticides included Paris green, which contained arsenic but was extremely effective on potato bugs; lead arsenate, used to eliminate gypsy moth cat-

erpillars; and calcium arsenate, used against cotton pests in the South. One problem associated with early pesticides was that they were often as dangerous to plants as they were to insects.

DDT was an important discovery because insecticides that had been in use were scarce because of World War II. In addition, DDT was effective against a variety of insects, including lice and mosquitoes. It was discovered after the war that DDT also was effective against a number of agricultural pests that plagued American farm production and Americans in general.

By 1960, DDT was a household word. Its use was so widespread that almost every person in the United States either had used the product or had heard of its use. It was partially because DDT was so well known that it was singled out for study by scientists who noticed irregularities in the environment.

At this time, during the peak of DDT use, two books were written about pesticides and their environmental impact. One of the books, *Silent Spring* (1962), written by marine biologist Rachel Carson, extensively outlined the effects of DDT on humans and on the environment. According to Carson, humans can become poisoned by DDT in a number of ways: by breathing the oily fumes that accompany its being sprayed, by ingesting food that has been sprayed with DDT, and by absorbing it through the skin. Because DDT is fat soluble, it is stored in organs rich in fatty substances such as the liver, the kidneys, and the adrenal and thyroid glands. DDT had been linked to cancer and blood disorders.

DDT did not disseminate in the environment. Accumulations of DDT remained in the soil and continued to contaminate plants and insects. Birds or other animals that ate insects or animals contaminated by DDT died or passed the contamination on to other animals through the food chain. There were questions as to whether DDT poisoning could be passed from a mother to her child through mother's milk and about a variety of illnesses that could result from DDT poisoning.

The other significant book written during this time was *The Poisons in Your Food* (1960) by journalist William Longgood. It was the first major journalistic attack against pesticides and caused the general public to become aware of pesticide dangers. The book outlined a number of toxic pesticides that had been used to restrict insects and

Picture used by the Industrial Hygiene Division of the U.S. Public Health Service during the 1950's to illustrate the dangers to farm workers of spraying toxic pesticides on agricultural fields.
(CDC/NIOSH)



promote agricultural growth. It also indicated that many poisons remained in food and were therefore consumed by human beings.

Both these books—especially Carson's, which would become a classic—stirred public interest in environmental concerns. That public concern led to the establishment in 1970 of the EPA, whose purpose was to protect and improve the environment. The EPA was responsible for controlling pollution through standard setting, enforcement, and research in the areas of solid waste, toxic substances, radiation, and noise. One of the first acts of the EPA was to amend the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 to restrict the use of DDT.

The federal government had banned use of DDT in residential areas on November 20, 1969, and called for a virtual halt to its use by 1971. Other countries took similar action. The EPA issued a cancellation order on the use of DDT in January, 1971. The Department of Agriculture appealed the order. In October of 1971, the EPA held hearings to determine the nature of the hazards of DDT use or misuse and the nature of benefits of the use of DDT. The EPA tried to determine if harms to humans associated with DDT occurred because it was misused or necessarily resulted even with proper use. The harms of using DDT then had to be weighed against the benefits of its use. One of the benefits of its use was increased food production, particularly important for countries that were dense in population. Land

had to be very productive to feed the people of such countries. The use of DDT also had eliminated hordes of mosquitoes, which had caused epidemic outbreaks of malaria, and it had eliminated lice infestations, which were responsible for numerous typhus epidemics. The EPA determined, however, that the harmful effects of DDT outweighed the benefits. If it remained in the environment for a long enough time, it could endanger a large number of people. DDT therefore was banned for use and production in the United States. European countries later followed suit.

SIGNIFICANCE

The banning of DDT in the United States and in Europe, along with hearings on pesticides and their use, alerted the public to the importance of environmental and ecological issues. The American public became involved by joining groups such as Greenpeace, the Sierra Club, the Audubon Society, the National Wildlife Federation, and the Wilderness Society; membership in these groups soon numbered in the millions. These groups lobbied Congress to pass additional laws to protect the environment. Lobbying efforts soon resulted in legislation concerning clean air, water pollution, noise control, drinking water, and toxic substances. These acts identified pollutants and set standards for their release into the environment. Standards were meant to identify the levels at which certain pollutants would be dangerous to people or the environment and to restrict emissions to those levels or below. The standards focused on factories and sewage plants at first. Later, standards would be expanded to include all pollutants.

Compliance with the standards was expensive. The EPA forced many companies to develop new processes or products in order to conform to standards. For example, auto companies were forced to alter their auto emissions systems to include a part called a catalytic converter. Auto companies also were forced to design more fuel-efficient vehicles, since gasoline had been identified as a pollutant as well as a natural resource. These changes added an estimated \$800 to the cost of each car sold in the United States. Other companies were required to find alternative places to dump their refuse or to do research and development on alternate uses for refuse. Even biodegradable refuse and, under some conditions, clean but warm water

were deemed harmful to the environment. Areas previously used as dump sites were discovered to contain toxic substances, and companies found to have used the sites were forced to pay to have these sites cleaned.

During 1988, corporations paid an estimated \$86 billion for pollution control, an amount equal to 2 percent of the Gross National Product. The Comprehensive Environmental Response, Compensation, and Liability Act was passed in 1980 in part to help firms pay the high costs of cleaning up old dump sites. Under this act, firms unable to pay to clean sites received assistance from the government, which had funds from petroleum and chemical production taxes set aside for this purpose. Business costs escalated in other ways, as firms were sued because of harm done to the environment. Hooker Chemical Company faced one such suit. When dangerous chemicals seeped from its barrels into the groundwater, people in a small community near Niagara Falls, New York, since called Love Canal, experienced increased rates of cancer, birth abnormalities, and other illnesses. The cost of settling the resulting suit was in the billions of dollars.

Costs continued to rise as other harmful or possibly harmful practices were identified. For American business, making a profit became complicated by concerns over environmental issues and possible future liabilities. Companies producing pesticides, for example, had to be concerned about the health and welfare of the populations of areas in which the pesticides were produced and used. The Food and Drug Administration (FDA) and the Environmental Protection Agency shared the responsibility for protecting the public from harmful substances in food. Manufacturers of pesticides and chemicals had to perform tests and prove the safety of their products as well as showing that residues did not accumulate beyond allowed levels. The FDA and EPA relied largely on tests conducted by the manufacturers themselves when registering pesticides. Consequently, some harmful pesticides, including dieldrin, Diazinon, Malathion, and lindane, remained in use. Pesticides by nature are harmful to at least some forms of life and may cause cancer, birth abnormalities, or nerve damage in humans. Some chemicals have not been tested for possible harmful effects. During the Ronald Reagan administration, testing all but halted. Concern mounted about pesticides such as alar

in apples, heptachlor in dairy products, and ethylene dibromide (EDB) in muffin and cake mixes. The release of toxic fumes from a chemical plant in Bhopal, India, in 1984 served as an example of the potential deadliness of pesticides. Thousands of people were killed in their sleep by toxic pesticide fumes, and hundreds of thousands more were injured.

The banning of DDT led to banning of other harmful substances in the United States and elsewhere. For countries with weaker economies or that are densely populated, the choice to restrict pesticides carried different costs and benefits. The risks of using harmful pesticides had to be balanced against the possibility of starvation or epidemic, and some countries could not afford the chemicals that could be used instead of those proved to be harmful. Pesticides will continue to be produced and used as long as insects continue to develop immunities to the chemicals being used. The challenges for business are to continue to balance pesticide use with other forms of pest control and to develop new safe and effective products. That concern with safety will also hold for wider environmental problems such as air and water pollution.

Elizabeth Gaydou-Miller

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■ 1970'S

ORGANIC FARMING GAINS IN POPULARITY

Organic farming became commercially feasible in the United States during the 1970's as increasing numbers of Americans became concerned about the health hazards of pesticides and the damage to the environment caused by traditional farming methods.

LOCALE: United States

AGRICULTURAL ISSUES: Chemistry; Ecology and environment; Fertilizers; Pests and pesticides; Scientific research

KEY FIGURES

Jerome Irving Rodale (1898-1971), founder of Rodale Press and a leader in organic farming education and research

Robert Rodale (1930-1990), son of Jerome Rodale and a leader in organic farming publishing and research

William A. Albrecht (1888-1974), soil scientist whose research focused on the relationship between plant and animal health and soil characteristics

SUMMARY OF EVENT

Early organic farmers were often ridiculed and accused of being radically opposed to technology and progress. In fact, they sought to implement as fully as possible the understanding of biological systems that science provided and to fight the misuse of technology. Those who favored organic agriculture believed that people in a democratic society should be free to farm as they desire yet should not be free to harm future generations, use up nonrenewable resources, or damage the environment.

In England and France in 1972, more than ninety thousand acres were farmed organically. In the United States, one of Jerome Irving Rodale's books on organic gardening was distributed to 750,000 readers. Under the leadership of Jerome's son Robert Rodale, the publishing company that Jerome founded, Rodale Press, continued

to publish materials on gardening, the environment, and human health and nutrition. Groups that focused on helping connect organic growers with markets for their crops—such as Natural Food Associates, founded in Texas in 1953—grew in importance during the 1970's. So-called ecological agriculture was also supported by soil scientists such as William A. Albrecht, who in 1971 began to publish a monthly newspaper for farmers titled *Acres, U.S.A.*

Scientific advances, as well as the pressure to feed an increasing world population, produced a modern agriculture dependent on external inputs for increased production. Before the twentieth century, researchers had discovered that row cropping, thorough tillage, weeding, and application of chemical fertilizers increased crop production and could perhaps assist in efforts to feed the world. Statistics gathered by the U.S. Department of Agriculture (USDA) illustrate the dramatic increases in crop yields between the late 1930's and the early 1970's: Corn yields increased 240 percent; wheat yields, 139 percent; cotton yields, 96 percent; potato yields, 214 percent; and strawberry yields, 342 percent.

These increases in production were accomplished because modern agriculture tended to substitute capital—in the form of machinery and chemicals—for labor and to increase the size of the farm unit. The environmental costs of these production practices included increases in pollution from chemical fertilizers and pesticides in air, water, and foods; decreases in food quality; depletion of soil and energy resources; and concentration on the production of single crops (monoculture) in specific geographic regions. Moreover, farmers suffered from the lower food prices that resulted from their increased productivity. In economic terms, the demand for food was comparatively inelastic—it did not respond to changes in prices.

Society paid the price for the loss of agricultural labor. As people who could no longer find work in rural areas moved to the cities, welfare and health care costs increased. Despite these developments, the USDA warned in 1971 that a change in conventional agriculture would force 50 million Americans into hunger or starvation. Consumers benefited from low food prices, but farmers using conventional techniques found it difficult to sustain profits while at the same time protecting the environment.

In 1964, farms with more than \$40,000 in sales were roughly twice

as likely to use pesticides as were farms with sales of less than \$10,000. The former tended to have better access to capital, to receive volume discounts, and to use different crop mixes. As the regional markets for small producers gradually disappeared, diversification became very costly. Scientists warned of the increased risk of crop failure from the intensive practice of monoculture. The overplanting of genetically related corn resulted in the corn blight of 1970, when the harvest decreased by 10 percent even though the acreage planted was up by 5 percent; some states suffered losses as high as 50 percent. In 1972, two types of peas and nine strains of peanuts made up 95 percent of the production of those two crops in the United States. An increasingly dangerous situation for producers and consumers was created as the gene pool shrank and pests developed resistance to pesticides.

Farmers who had chosen alternative methods of agriculture argued for the maintenance of genetic diversity in both plant and animal stocks and for the protection of the environment. Federal agriculture policy, however, was biased toward conventional agriculture. A 1975 study by the National Academy of Sciences determined that the USDA had neglected basic scientific research, focusing instead on large-scale farming and productivity, although only 16 percent of U.S. farms had 1974 sales in excess of \$40,000, while 52 percent had sales of less than \$10,000. Little research had been done that could help farms with low incomes; indeed, many of the studies conducted seemed directed against their survival. From 1950 to 1975, the number of U.S. farms decreased by 50 percent.

Conventional farming practices can create severe environmental problems. In 1935, for example, such practices resulted in the loss of three billion tons of soil from cultivated lands in the United States. During the next three decades, the Soil Conservation Service supervised the expenditure of \$11 billion to address the problem, yet four billion tons of soil were lost in 1964. In Great Britain in 1970, soils were declared incapable of maintaining crop production at their current levels as a result of a dangerous depletion of organic matter.

The pesticides used in conventional agriculture have often been successful in initially protecting crops but have generated unexpected effects on ecosystems, including, in some cases, a return of pests in even larger numbers. Pesticide residues in human food have



Greenhouse in which organic cucumbers are grown. (PhotoDisc)

been linked to allergies, cancers, and many other health problems. The manufacture and shipment of pesticides, moreover, have often resulted in disastrous accidents and subsequent contamination of the environment. By contrast, a major premise of organic farming is the ability of healthy plants growing under ideal conditions to protect themselves from pests through natural processes.

During the late 1960's, public pressure across the United States led to restrictions on the use of organochlorine pesticides in agriculture. The chemicals that replaced them were less persistent in the environment and food chain but potentially more toxic to the farmer. The substitutes of the 1970's also tended to be more toxic to bees and other beneficial predators and to exert harmful physiological effects on crops. In 1970, the U.S. Congress passed the Occupational Safety and Health Act, which required hazard-free work environments for all types of workers, including farmworkers.

Public pressure and the potential dangers of pesticides forced farmers to make choices in favor of the environment and worker health. Farmers were faced with public concerns about pollution and consumer health, the increased cost of conventional farming and dependence on industry, overproduction of low-quality food, low

NATIONAL STANDARDS FOR ORGANIC CERTIFICATION

The U.S. Department of Agriculture's National Organic Program published a fact sheet in October, 2002, that explains the national standards for the certification of organic products laid out in the 1990 Organic Foods Production Act:

The national organic standards address the methods, practices, and substances used in producing and handling crops, livestock, and processed agricultural products. The requirements apply to the way the product is created, not to measurable properties of the product itself. Although specific practices and materials used by organic operations may vary, the standards require every aspect of organic production and handling to comply with the provisions of the Organic Foods Production Act (OFPA). Organically produced food cannot be produced using excluded methods, sewage sludge, or ionizing radiation.

Crop standards

The organic crop production standards say that:

Land will have no prohibited substances applied to it for at least 3 years before the harvest of an organic crop. The use of genetic engineering (included in excluded methods), ionizing radiation and sewage sludge is prohibited. Soil fertility and crop nutrients will be managed through tillage and cultivation practices, crop rotations, and cover crops, supplemented with animal and crop waste materials and allowed synthetic materials.

Preference will be given to the use of organic seeds and other planting stock, but a farmer may use non-organic seeds and planting stock under specified conditions. Crop pests, weeds, and diseases will be controlled primarily through management practices including physical, mechanical, and biological controls. When these practices are not sufficient, a biological, botanical, or synthetic substance approved for use on the National List may be used.

Livestock standards

These standards apply to animals used for meat, milk, eggs, and other animal products represented as organically produced. The livestock standards say that:

Animals for slaughter must be raised under organic management from the last third of gestation, or no later than the second day of life for poultry. Producers are required to feed livestock agricultural feed products that are 100 percent organic, but may also provide allowed vitamin and mineral supplements. Producers may convert an entire, distinct dairy herd to organic production by providing 80 percent organically produced feed for 9 months, followed by 3 months of 100 percent organically produced feed. Organically raised animals may not be given hormones to promote growth, or antibiotics for any reason. Preventive management practices, including the use of vaccines, will be used to keep animals healthy. Producers are prohibited from withholding treatment from a sick or injured animal; however, animals treated with a prohibited medication may not be sold as organic. All organically raised animals must have access to the outdoors, including access to pasture for ruminants. They may be temporarily confined only for reasons of health, safety, the animal's stage of production, or to protect soil or water quality.

prices, and scarcity of affordable labor. Many observers blamed corporate sales forces and university experts for having led farmers into high-cost production, high debt, and low profit. As conventional farming became more expensive while the prices paid per unit rose slowly, increasing numbers of American farmers learned the value of organic techniques.

Organic farming involves minimizing the use of costly pesticides and other treatments by using practices long known to agriculture. These include crop rotation, mechanical methods of weed control, and maximized application of scientific knowledge to all aspects of farming. Organic farming promotes the production of highly nutritious food crops by cooperating with nature, understanding biological cycles, maximizing soil fertility, using a minimum of artificial fertilizers and organic matters, maintaining livestock ethically, avoiding environmental pollution, and protecting the genetic diversity of plants and animals. Moreover, many organic farmers believe that farming is part of a broader social, economic, and ecological agenda.

SIGNIFICANCE

During the late 1960's and 1970's, the desire for organically produced food increased dramatically in the United States. Many believed that the effects of pesticide residues were cumulative and could not be fully assessed for many years; certainly, there was increasing evidence that wildlife was being dramatically affected by pesticides. As consumers turned to organically produced foods, the prices of such foods decreased, and, in turn, demand increased further.

Many Americans initially perceived organic farming as a hobby for part-time or gentlemen farmers. Organic agricultural practices were not widely adopted at first primarily because of economic factors. During the 1960's, the incomes of farmers were 20 percent lower than the incomes of other American workers, and although farm income rose during the early 1970's, many farmers tried to maximize short-term profits by adopting new technologies.

During the 1970's, higher prices for chemical fertilizers and increasing federal restrictions on some pesticides increased the costs of conventional farming. Nevertheless, those who chose to farm organically did so knowing that they were taking a risk. Many farmers who

changed to organic techniques did so to improve the health of their families, often after negative experiences with pesticides. Some farmers changed their practices to improve the health of their livestock. Still others viewed farming as a spiritual relationship with the land; their motivations included a concern for protecting the environment.

Organic farmers were gradually able to make larger profits. A survey of farm prices of organic food found little difference between organic and conventional vegetable and fruit prices in California, but nationally the major field crops cost 10 percent more when raised organically. The largest impacts of large-scale changeovers were felt with crops such as corn, soybeans, and wheat; many organic growers of these crops claimed to be able to produce competitive yields after the initial conversion period. Organic farming also became linked with integrated pest management, an approach in which low levels of pest infestations—which would have been uneconomical to treat with pesticides—were allowed to exist, encouraging the buildup of favorable predators and parasites.

For developing countries, rapidly increasing populations, combined with deterioration of soil as a result of erosion and desertification, made the likelihood of success with organic farming more problematic. International organizations such as the World Bank and the United Nations, however, eventually declared that the use of conventional agriculture presents threats to human health and to the environment and does not lead to sustainable and profitable agricultural production. Most international agricultural experts thus continued to believe not only that organic farming was the answer for feeding the world but also that it was the only economic solution for sustainable agriculture.

Michele Barker-Bridgers

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■ JUNE 16, 1970

BRAZIL PLANS HIGHWAY TO PROMOTE AGRICULTURE IN THE AMAZON

The president of Brazil announced plans to build the Trans-Amazon Highway, which would link the nation's coastal cities with its interior in an effort to promote agriculture and economic development in the country's vast interior.

LOCALE: Amazon River Basin, Brazil

AGRICULTURAL ISSUES: Cattle keeping; Ecology and environment; Tropical produce

KEY FIGURES

Emílio Garrastazu Médici (1905-1985), president of Brazil, 1969-1974
Chico Mendes (1944-1988), Brazilian rubber tapper and spokesman for the Workers' Party

José Lutzenberger (1926-1975), Brazilian secretary of the environment,
José Sarney (b. 1930), president of Brazil, 1985-1990

Francisco de Orellano (fl. mid-sixteenth century), Spanish conquistador

SUMMARY OF EVENT

From the time the Spaniard Francisco de Orellano, a conquistador in search of gold and cinnamon while in the service of Francisco Pizarro, became the first European to navigate its full length, the Amazon basin has presented a vision of riches for explorers, adventurers, and settlers. According to Orellano's scribe, among the many Indian bands battling the Spaniards during their expedition were several tall, fair, long-haired women whose warrior skills equaled those of ten men. Orellano called the women "amazonas" and thereby gave the world's greatest river its name.

Along with the name, the legend of the Amazon as a land of limitless wealth has persisted over the centuries. During the 1960's, President Juscelino Kubitschek built the new inland capital city of Brasília to focus the attention of the Brazilian people on the untapped potential of the nation's vast interior. On June 16, 1970, after a visit to the

drought-stricken, impoverished northeast of Brazil, President Emílio Garrastazu Médici ordered the construction of a highway to open the rain forest to the northeast's land-hungry peasants. When announcing this order, Médici called the Amazon basin "a land without men for men without land," ignoring the many groups of indigenous people who had lived for millennia along the Amazon and its many tributaries. With this order, Médici initiated decades of unforeseen and undesired consequences.

The highway begun by Médici is still under construction. Completed portions link the cities of the northeast coast of Brazil with Manaus, the city built at the confluence of the Amazon and the Rio Negro during the late nineteenth century rubber boom, and Porto Velho, a river port situated at the uppermost navigable reaches of the Rio Madeira in the state of Rondonia. The road from Porto Velho continues westward to Rio Branco on the border with Bolivia and to Cruzeiro do Sul on the border with Peru. North of the Amazon, another portion of the road extends to Boa Vista near the borders with Guyana. Additional portions are planned to link Manaus with Benjamin Constant, where Brazil meets Peru and Colombia, and Sao Gabriel da Cachoeira, near the borders with Colombia and Venezuela.

As these roads progressed into the Amazon basin, the poor and landless of Brazil's southern and northeastern states migrated into the rain forest in search of land upon which to build new lives for themselves and their families, but not in the numbers intended. Médici's goal had been the settlement of seventy thousand families by 1974, but by that date only about six thousand families had migrated to the region. During the 1970's, while the population of the whole of Brazil grew at a rate of 2.8 percent per year, the Amazon region's population expanded at a rate of 6.3 percent, and in Rondonia it rose by an incredible 34.2 percent per year. Despite this migration, by the end of the 1970's the Amazon basin, occupying over 40 percent of Brazil's land area, still had less than 5 percent of the country's total population. In fact, the population density of the Amazon was roughly equal to that of the Sahara Desert in Africa.

The lush tropical forests have long led the people of Brazil to believe that the Amazon, if cleared of its forests, could become the world's breadbasket. The people who migrated to the region tried to realize that dream, but more often than not their crops failed, and

JUNE 16, 1970

the lives they found proved little better, and often worse, than those they left behind. Upon arrival in the region, these people would locate a parcel of land and, like the homesteaders of the American prairies, would claim it as their own. The average size of these parcels was about 100 hectares (250 acres). The settlers would clear away the forest, often using bulldozers, and plant crops such as corn, manioc, brown beans, or other staples. These crops usually fared well for the first year or two, but soon enough the soil would take on a hard, red, bricklike quality, its fertility exhausted, and the fields would be either bare or overrun by invading woody vegetation.

The few studies of the potential productivity of the region have found that, because of the poor soils and the delicate ecological balance of the Amazonian ecosystems, perhaps no more than 5 percent of the entire region, mainly those portions lying immediately along the rivers, is suitable for annual crops. Lacking adequate knowledge and means to evaluate the potential of a parcel of land to sustain agricultural productivity, most of the migrants to the Amazon learned of the fragility of that ecosystem the hard way, and usually too late.

The tragedy of these failures spread as the migrants abandoned their land, often selling it for little if any return to the agents of absentee landowners, who typically were wealthy people living hundreds of miles away in Rio de Janeiro and São Paulo. The migrant families then either returned to the hard lives they had hoped to escape or moved deeper into the Amazon forests to clear land occupied by indigenous people.

In the latter case, violence was common between both settlers and Indians and settlers and the widely scattered *serengueiros*, rubber tappers who collected the latex needed to make rubber and harvested jungle fruits and medicinal plant products. The agents of absentee landowners, usually seeking to clear the land again and convert it to cattle pasture to collect government subsidies, also used violence to seize the land of the Indians, the *serengueiros*, and the migrant settlers as well. The grand plans to use the Amazon as a vast pasture also failed. The productivity of the rangelands was so low that huge expanses of land were needed to produce even the smallest profit, and just as the settlers had discovered with their crops, soon the soil would not support the grasses needed to sustain cattle. The jungle would then creep back to reclaim the land.

SIGNIFICANCE

The impact of the Trans-Amazon Highway system was both global and local. These effects ranged from the purely theoretical to the clearly tangible. Among the theoretical effects were the claims by environmental groups in the United States and Western Europe that deforestation in the Amazon would increase the potential for global warming. These claims are based on the belief that felling the forest would not only reduce the uptake of atmospheric carbon but also release additional carbon into the atmosphere as the vegetation decomposed, although existing data on these claims are contradictory and inconclusive.

Another global-scale impact that has worried some biologists, ecologists, and other natural scientists is the loss of biological diversity that occurs as deforestation eliminates species, niches, and habitats. Tropical rain forests are the most biologically diverse of all the earth's terrestrial ecosystems, as well as the most biologically produc-



Rubber gatherer tapping natural latex from a tree with a machete. (Library of Congress)



Early twentieth century Brazilian rubber plantation workers carrying rubber they have tapped from trees to a collection center. (Library of Congress)

tive. Some biologists have claimed that species of both plants and animals are being eliminated at high rates by deforestation, although numbers to support these claims are so far only speculative. Nevertheless, large-scale human encroachment on these ecosystems in Asia, Africa, and Latin America, even if it does not reduce their long-term productivity, cannot help but reduce their biological diversity. Most human settlement in the Amazon has occurred in the eastern and southern portions of the basin, while the best estimates indicate that biological diversity is greatest in the northwestern regions.

A third global impact has occurred in politics and economics. Environmental groups in the United States and Western Europe have amassed enormous financial resources to lobby their governments and support the work of sympathetic scientists in an effort to bring pressure on many tropical countries, especially Brazil, to preserve their rain forest resources. This pressure has even reached the level of the World Bank, a major lender to Brazil, which in recent years has worked directly with Indians and *seringueiros* to set aside large areas of

the upper Amazon and has pressured the Brazilian government to protect these lands as a condition for continued international financial support. Predictably, Brazilians have taken great offense at this infringement on their national sovereignty.

During the early 1980's, encouraged by Brazil's economic health and the anger many Brazilians felt over outside interference in their domestic affairs, President José Sarney accelerated the construction of the Trans-Amazon Highway, seeing integration of the Amazon into the nation's economy as the best course for continued development. As his foreign minister stated, "Brazil will not see itself turned into a nature preserve for the rest of humanity. Our most important goal is economic development."

One local event brought a global change. In 1988, Chico Mendes, a *seringueiro* and leader of Brazil's Workers' Party (Partido de Trabalhadores), was murdered. His close contacts with many American and European environmental groups meant that his death received worldwide publicity. This publicity, combined with a severe downturn in Brazil's economy, itself caused in part by the failures of Sarney's efforts to develop the Amazon, brought a new man, Ferdinand Collor, to Brazil's presidency, and with him a new secretary for the environment, José Lutzenberger. Lutzenberger formed a Center for Tropical Forest Research to study the problem of sustainable development in the Amazon and began an ambitious program to zone the Amazon; that is, to designate which areas might be developed, which should be preserved for their biological value, and which should be fully titled to their indigenous occupants. These research and zoning efforts are the main focus of Brazil's plans for developing the Amazon.

The most tangible impacts remain local and continue to occur. Thousands of Brazil's poor chased an unrealizable dream deep into the jungle and found only misery. Instead of establishing successful farms to support themselves and their families, they left parts of the Amazon bare of the great forests that had stood for millennia. Estimates indicate that almost 7 percent of the entire Amazon has been logged since the Trans-Amazon Highway was begun, and greater portions have been cleared in the states of Rondonia in the west and Amapa in the east.

Along with parts of the Amazon forest, many of the families who migrated there and were unable to support themselves were also de-

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stroyed. Men often migrated to remote gold fields in the Amazon to become laborers in near-slavery conditions. Left behind, women tried to support their children alone, in many cases becoming prostitutes in order to survive. The lands these families lost became part of vast cattle ranches. Meanwhile, traditional gatherers of the Amazon saw their forests devastated, and others, like Chico Mendes, were killed defending their lands. Rather than solving the poverty of Brazil, the Trans-Amazon Highway more often let the rich get richer and the poor get poorer.

The most tragic impact befell the Indians, many of whose societies have have lived for thousands of years within the Amazon forests. Lacking modern medical technology and practicing traditions of warfare, these people rarely enjoyed long lives; however, their lives have been further shortened by both economic conflict and exposure to diseases against which they have no resistance. The conflicts are over control of the land and over the desire of migrants and others seeking gold and other minerals in the Amazon. As these Indians have disappeared, so has their knowledge, acquired over the millennia, which enabled the Indians to harvest food and medicinal crops without destroying the soil or the forest. It enabled them to identify which parts of the rain forest were most adaptable for human use and which were not. To date, only these Indians have demonstrated the knowledge and ability to capture the wealth of the Amazon, wealth that adventurers since the time of Orellano could see but never hold.

Paul Chandler

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■ DECEMBER 4, 1970

CHÁVEZ IS JAILED FOR ORGANIZING NATIONAL LETTUCE BOYCOTT

Labor organizer and farmworkers' rights leader César Chávez was jailed for boycotting lettuce growers, elevating him to the status of champion of the oppressed and the poor in the minds of many Americans. The boycott led to legislation that benefited farmworkers.

LOCALE: Salinas, California

AGRICULTURAL ISSUES: Agrarian reform; Labor; Migration

KEY FIGURES

César Chávez (1927-1993), farmworkers' rights activist, labor union organizer, and founder of the United Farm Workers of America
Dolores Huerta (b. 1930), farmworkers' rights activist, labor union organizer, and cofounder and vice president of the United Farm Workers of America

Jerry Brown (b. 1938), governor of California, 1975-1983

George Meany (1894-1980), first president of the American Federation of Labor-Congress of Industrial Organizations

Robert F. Kennedy (1925-1968), attorney general of the United States, 1961-1964, and senator from New York, 1965-1968

John V. Lindsay (1921-2000), mayor of New York City, 1966-1973

SUMMARY OF EVENT

Throughout the history of the farm labor movement in California, growers have relied on a cheap, dependable workforce that has been composed primarily of minorities. The state's first farmworkers were American Indians. The Native American population in the state was reduced from an earlier level of 300,000 to 30,000 in 1860 through disease and ill treatment. Native Americans were replaced by Chinese, who had been brought to America to help construct the Central Pacific and the Union Pacific railroads. The Chinese were eager to work in America, even though thousands succumbed to disease on the passage across the Pacific. When farmers replaced livestock and



*Lettuce harvesting
in California's
Salinas Valley.
(Library of
Congress)*

wheat with fruit and truck crops toward the end of the nineteenth century, even more Chinese immigrated, until Congress suspended Chinese immigration in 1882.

At almost exactly the same time that the Chinese labor supply was cut off, Japan relaxed its long-standing ban on emigration, and workers from Japan began to pour into California. By 1910, their numbers had swollen to more than forty thousand. Even though the Japanese were industrious, they were not ideal workers from the growers' viewpoint because they dreamed of owning land and becoming farmers in their own right. Agitation over the "yellow peril" and the "rising tide of color" in California culminated in 1924 in a new immigration act that ended immigration from Asia. Fortunately for the growers, the Mexican Revolution of 1910 opened another pool of foreign labor.

Tens of thousands of rural families fled Mexico, and by 1920 the census reported nearly 100,000 Mexican nationals in California. Between 1942 and 1964, California received special dispensation to use Mexican contract workers. The influx of these *braceros* (literally, "arm-men") increased the Mexican population in the state by 100,000. For the most part, the growers welcomed the contract workers because they could be forced to work for whomever they were told under terms set by the growers. In addition to those who immigrated

legally from Mexico, an untold number of workers crossed the border illegally into the United States. In some ways, these workers were entirely at the mercy of employers and labor contractors. Except for a brief period during the 1930's, when thirty thousand Filipinos were imported to California, Mexicans provided the bulk of the farm labor force for most of the twentieth century. Mexican immigrants fit the growers' concept of the perfect labor force because they did not, for the most part, aspire to land ownership or to fringe benefits.

For nearly one hundred years, agricultural employers beat back attempts to organize the workforce. Prior to the 1960's, migrant workers had never won collective bargaining rights because they had not been highly motivated to organize. In addition, their itinerant lives made it difficult for them to meld into a solid group. Although the farm labor movement was active during the twentieth century, it was not very effective, primarily because leadership did not come from the groups that made up the workforce. Leadership came from political groups (such as the Industrial Workers of the World), intellectuals (such as Ernesto Galarza), urban unionists (such as Norman Smith and Clive Knowles), and the clergy (such as Father Thomas McCullough).

César Chávez succeeded where his predecessors had failed partially because he worked in the fields as he organized and was trusted by the farmworkers as no other leader had been. As the son of migrant workers, Chávez and his family had lived in their car or in tents without heat or light, had gone without shoes in the winter, and had eaten mustard greens to stay alive. Chávez and his brothers and sisters attended segregated schools, which provided little more than child-care service.

Until his family learned the tricks of the labor contractors, they had worked hard harvesting fields only to be cheated by growers when the work was completed. There was no job security, and fringe benefits were few. The labor camps that they lived in periodically were a collection of nine-by-eleven-foot tin shacks that collected the heat of the summer sun and lacked indoor plumbing. Many of the conditions that Chávez's family and thousands of other Mexican families experienced were similar to those endured by the waves of Chinese, Japanese, Mexican, and Filipino workers who had preceded them.

Chávez became involved in the farm labor movement almost by accident. Like many second-generation Mexican Americans, he and his wife had left the migrant stream and probably would have left agricultural work altogether if Chávez had not spoken to Father Donald McDonnell. Father McDonnell got Chávez interested in the farm labor movement by telling him about Pope Leo XIII's endorsement of labor unions. Through Father McDonnell, Chávez met Fred Ross, a representative of the Community Service Organization (CSO) who had come to California to set up local chapters. In 1953, Chávez became a statewide organizer for the CSO and, with the help of his principal assistant and a labor organizer in her own right, Dolores Huerta, built the CSO in California to twenty-two chapters. After ten years, Chávez left the CSO because, unlike many CSO leaders, he believed that it would be better for his people to end the bracero system and upgrade farmwork instead of fleeing to an uncertain future in the cities. He believed that farm labor organizing should be emphasized much more than it was.

After withdrawing his life savings of \$900 in April, 1962, Chávez and his family moved to Delano, where he founded the National Farm Workers Association that same year with no outside help. The NFWA's first big strike was the Delano grape strike, in response to a cry for help in 1965 from the Filipino grape pickers in Delano. At that time, grape pickers in Delano received \$1.20 an hour, which was \$.45 less than the federal minimum wage. The pickers lived in shacks with no heating or plumbing. In addition, pickers were often accidentally sprayed with insecticides. At stake were the interests of 384,100 farmworkers in California and four million agricultural workers in the United States.

To keep pressure on the table-grape growers, Chávez and Huerta decided in 1967 to stage a nationwide boycott against them. By 1968, with the support of the Roman Catholic Church and such influential Americans as Senator Robert F. Kennedy and New York City mayor John V. Lindsay, the boycott succeeded in lowering grape sales by 12 percent. Chávez's twenty-five-day fast in 1968 united California's farmworkers behind the movement and established Chávez as a hero. Victory was finally achieved in 1970 when the largest producer among grape growers in the United States, John Giumarra, Jr., signed contracts recognizing the existence of the union (known by this time

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as the United Farm Workers Organizing Committee, or UFWOC), and agreeing to pay \$1.80 an hour plus \$.20 for each box of grapes. Chávez proved for the first time that field-workers could force an entire industry—85 percent of the grape growers in California—to sign a contract with their union leaders.

Fresh from the triumph of *La Huelga* (the strike), Chávez embarked on a much more ambitious crusade. This time the product was lettuce, picked by workers in California and Arizona. The lettuce growers not only had the support of corporations such as Purex but also were backed by the U.S. Defense Department, which had refused to buy any “union lettuce.” The UFWOC’s primary target was Bud Antle’s huge ranch in the Salinas Valley. Antle was one of many growers in Salinas, King City, the Imperial Valley, and the San Joaquin Valley who had secretly signed contracts with the Teamsters in an effort to destroy the UFWOC.

On September 17, 1970, Chávez announced that the UFWOC was sending people to sixty-four cities in North America to organize a national boycott of lettuce. Chávez’s announcement was in direct defi-



César Chávez (with hand atop his placard) and Coretta Scott King (second from left) leading a march in support of the lettuce boycott in New York City during the early 1970's. (Bob Parent/Hulton Archive/Getty Images)

ance of Superior Court Judge Anthony Brazil's decision the day before to grant permanent injunctions against picketing to thirty growers, on the grounds that this was a jurisdictional dispute that was illegal in California. Knowing full well of the publicity that would develop if he were jailed, Chávez continued the boycott against Antle and ordered that the following statement be given to the press on the day that he went to jail:

Boycott Bud Antle! Boycott Dow Chemical! And boycott the hell out of them! Viva!

Chávez's contempt-of-court trial was held on December 4. The presiding judge, Gordon Campbell, sentenced Chávez to jail on each of two counts of contempt of court and ordered that he remain in jail until he notified all UFWOC personnel to stop the boycott against Antle. The judge also fined Chávez \$500 for each of the two counts. Chávez's jail sentence generated the attention that he had hoped for. While he was in the Salinas County Jail, visits to Chávez by Coretta Scott King and Ethel Kennedy were covered by the national press and the major television networks.

A week after Chávez was jailed, the State Court of Appeals denied a union petition that the Antle injunction be set aside. The UFWOC then appealed the decision to the California Supreme Court, which ordered Chávez's release twenty days after he was jailed. During a mass of thanksgiving that was held in the parking lot, Chávez told a crowd of about four hundred union supporters, "Jails were made for men who fight for their rights. My spirit was never in jail. They can jail us, but they can never jail the Cause." Four months later, the California Supreme Court ruled that the UFWOC had the right to boycott Bud Antle.

SIGNIFICANCE

Chávez was correct in his assumption that the contempt-of-court trial and his subsequent jail sentence would bring *La Causa* (the farm labor movement) to national attention. Chávez's charismatic leadership, which was based on Mahatma Gandhi's philosophy of passive resistance, convinced many Americans that Chávez was the logical successor to Martin Luther King, Jr., and Robert Kennedy. The politi-

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cal ramifications of Chávez's jailing extended to both the union halls and the courts.

The Teamsters' fear that the court hearing would turn public opinion against them was well founded. In 1973, when the Teamsters called in about one hundred "guards" at \$67.50 per day to protect strike breakers from interference by Chávez's pickets, newspapers across the nation branded them as "goon squads." Convinced that the Teamsters and the growers were jointly seeking to destroy the farmworkers, George Meany threw the full support of the AFL-CIO behind the grape and lettuce boycotts on April 8, 1974. Finally, in 1979, the Teamsters signed a "peace treaty" with the UFWOC that gave the field hands to the UFWOC and the canners, packers, and farm-truck drivers to the Teamsters. This was an amazing concession, considering that the Teamsters had already persuaded 50,000 of California's 250,000 agricultural workers to join them rather than the UFWOC. This uneasy alliance was primarily the result of the Teamsters' desire to repair the damage that their union's image had suffered through their dispute with the UFWOC.

Chávez's skill at persuading liberals to regard the boycotts of grapes and lettuce as a just cause eventually produced legislation that benefited the workers. Sensing that allying himself with the farmworkers would help him to be elected governor, Jerry Brown made the creation of workable farm labor relations law one of his primary goals. In September, 1975, the state's Agricultural Labor Relations Act took effect. The main impetus of this law was the formation of the Agricultural Labor Relations Board, which gave labor organizers access to the fields. Although the ALRB was too poorly funded to be truly effective, its very existence testified to the belief of many lawmakers in California that the labor disputes were another manifestation of California's problem of interethnic relations between employers and workers. They interpreted Chávez's crusade as a struggle not simply for economic security but also for minority self-determination.

Of far more importance than Chávez's achievements is the way his nonviolent approach to social change carried over to other movements. He demonstrated through his deep emotional commitment to the UFWOC that people of various backgrounds, political persuasions, and faiths will come together for a common cause if it is mor-

ally correct. The truth of this statement is born out by the fact that the techniques developed by La Causa have been successfully applied by farmworkers in other lands. Chávez also showed through his courage and hard work that individuals really can make a difference.

Alan Brown

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■ DECEMBER 10, 1970

BORLAUG RECEIVES NOBEL PRIZE FOR WORK ON WORLD HUNGER

Norman Borlaug received the Nobel Peace Prize for developing a disease-resistant strain of dwarf wheat that increased food production and helped feed the world's hungry, thereby preventing widespread famine.

LOCALE: Oslo, Norway

AGRICULTURAL ISSUES: Botany; Disease and health issues; Famine and hunger; Fertilizers; Genetic engineering; Scientific research

KEY FIGURES

Norman Borlaug (b. 1914), American plant pathologist

William Earle Colwell (b. 1915), American agronomist

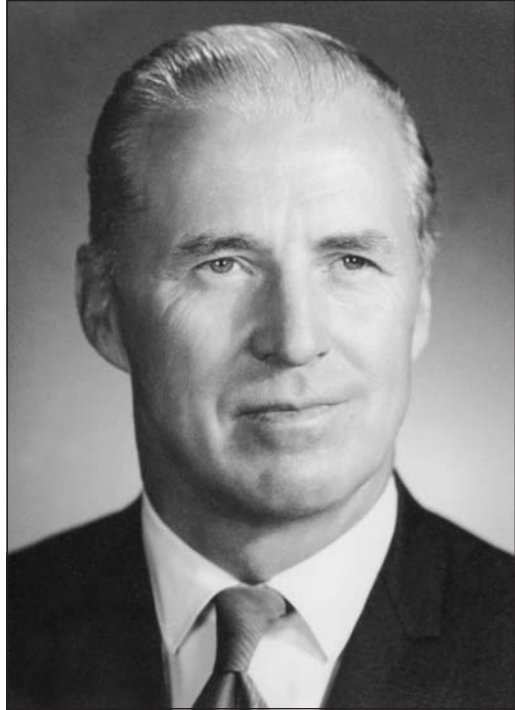
Jacob George Harrar (1906-1982), director of the Rockefeller Foundation's Mexican Agricultural Program, 1943-1951, and president of the Rockefeller Foundation, 1961-1972

Henry A. Wallace (1888-1965), vice president of the United States, 1941-1945, who recommended expanded agricultural research

SUMMARY OF EVENT

In 1944, under the auspices of the Rockefeller Foundation, thirty-year-old Norman Borlaug, two years after earning his doctorate in plant pathology at the University of Minnesota, joined a team of agricultural researchers working in Mexico. The team, part of the Rockefeller Foundation's Mexican Agricultural Program, led by Jacob George Harrar, was assigned to help the Mexican government improve its agricultural yield, which for several reasons had reached far below its potential, and to help the impoverished nation and its people avoid famine.

Mexico had been suffering from widespread hunger, and much of the populace, particularly in rural areas, had little reason to hope that their lives could ever improve. Agriculture was held in low esteem as a vocation, and what revenues it produced found its way into urban rather than rural projects.



Norman Borlaug.
(©The Nobel Foundation)

During the mid-1940's, Mexican farming was notoriously unproductive. Farms in the country averaged eight bushels of corn from each acre, compared to twenty-eight bushels in the United States. Wheat production per acre in Mexico was about 75 percent what it was on the farms of its northern neighbor. To feed its population, Mexico had to import 50 percent of its wheat, causing a crushing balance of payments deficit. By 1948, Borlaug's work had made it possible for Mexico to stop importing wheat.

When Borlaug arrived in 1944, the Rockefeller project was vastly understaffed, although agronomists and plant pathologists such as Harrar and William Earle Colwell were moving toward solutions. The political climate had been improved by U.S. vice president Henry A. Wallace's call for an increased emphasis on world agricultural development. Severe problems persisted, however, for the next two decades and beyond. The project's work was often impeded by bureaucratic regulation, both its own and that of the Mexican government agencies with which it worked. Borlaug, sensing some of the prob-

lems that hampered progress, put into effect a new set of criteria under which the project would operate.

To begin with, Borlaug established a set of priorities and saw to it that they were observed. The first priority was to focus on a single crop, wheat, and to focus even more narrowly on one major problem related to that crop, the growth of the rust fungus that attacked wheat and wiped out whole fields of the grain before it was mature. The ultimate aim of this priority was to feed large numbers of hungry people as quickly as possible. Borlaug further mandated that theoretical and applied science would be valued equally and that the project would emphasize whatever seemed most likely to help it achieve its stated priorities. In practice, Borlaug did not favor basic over applied science. He realized that a symbiotic relationship existed between the two, and he acted accordingly in his capacity as director. Finally, Borlaug saw to it that the scientists who were placed in charge of the project's various programs were hired as long-term researchers, not as experts who came into situations they knew little about, gave theoretical advice, and then departed before the actual program was functional, as had frequently been the practice. Borlaug insisted that young local people who had a stake in the region be brought in as trainees. Those who excelled in their internships were given subsidies to pursue further study that would enable them eventually to run the project. The ultimate aim was to turn the entire operation over to well-trained Mexicans and to get the Rockefeller Foundation out.

Part of the challenge Borlaug and his colleagues faced was to increase production from soil that had in some cases been worked for almost two millennia without regard to replacing its nutrients. Fertilization was an obvious solution, but once it was instituted, it caused its own problems. Wheat grown in well-fertilized fields grew tall, and farmers were elated until rain and windstorms left the wheat prostrate in the mud before it could be harvested. Borlaug had to work on this problem while simultaneously experimenting with crossbreeding of various strains of wheat to find one that was rust-resistant and that could be grown successfully in all of Mexico's varied climatic regions. His experiments involved growing two crops of wheat a year in four discrete climatic zones in Mexico. When his crossbreeding, which involved as many as six thousand crosses a year, began to yield results, Borlaug had to find ways to disseminate his findings. He de-

cided to hold a field day for local farmers, who were reputed to be resistant to change. Five skeptical farmers attended the first field day at the test plots in Valle de Yaqui in Sonora, northwest of Mexico City. Three years later, hundreds of farmers attended a similar field day, and, in less than a decade, the event attracted thousands from the whole of northern Mexico.

Illiterate Mexican farmers had been resistant to programs that offered them no practical outcomes. Once they realized that the seeds they obtained from Borlaug increased their yields substantially and reduced the invasions of the rust fungus that had previously destroyed their crops, they became cooperative—indeed, enthusiastic—followers of this down-to-earth leader. Out of one test of five thousand crosses, Borlaug found two strains that could resist the rust fungus. This fungus, however, was insidious. It could undergo rapid mutations that enabled it to attack resistant strains, so no victory could be considered an immediate triumph.

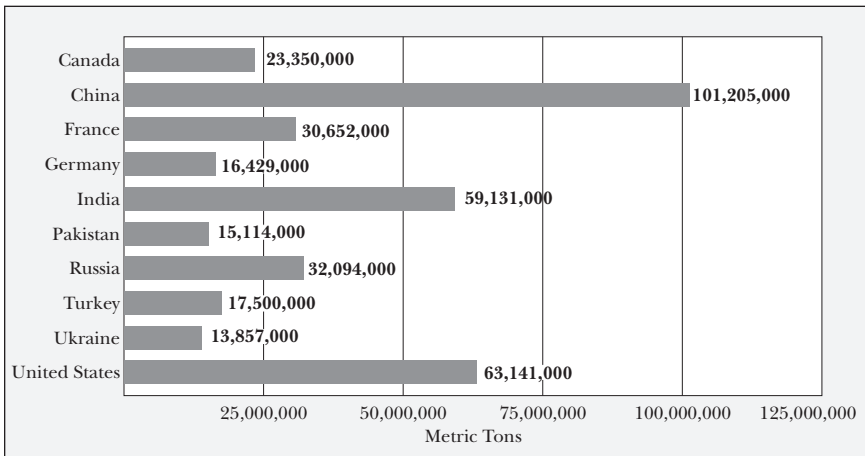
Borlaug saw unfolding before him some of the problems Thomas Robert Malthus had identified two centuries earlier concerning explosive population growth. Mexico's population was doubling every twenty-five years, an increase that threatened to cancel the strides Borlaug's methods made possible. Borlaug stressed the urgency of controlling population if his work was to have any impact in eliminating hunger. In an attempt to find better strains of wheat than were available to him, Borlaug looked to other parts of the world. In Japan during reconstruction after World War II, General Douglas MacArthur had assigned agronomists to work on the food problem. They had found that Japanese farmers were growing a dwarf wheat, Norin 10, previously unknown outside Japan. In 1946, the U.S. Agricultural Research Service made sixteen varieties of Norin wheat available to wheat breeders. This strain used water and nutrients from the soil in a highly efficient manner to develop more leaves than stalk, making for a compact entity that produced more grains of wheat on each plant than Borlaug had ever dreamed possible. Norin, however, was not without its own problems.

The wheat sprouted subhumusly at the wrong time in the United States and Mexico. Researchers at the Agricultural Research Service in Washington worked on this problem and, by the late 1950's, had produced a strain, Gaines, that was insensitive to light, thereby over-

coming the sprouting problem. This was a major turning point for Borlaug. Here was a remarkably prolific strain of wheat that could be fertilized heavily, which was necessary in Mexico's depleted soil, but that would stand erect through various climatic exigencies. Borlaug began crossbreeding the Gaines strain with some of his Mexican strains and finally, by 1961, had two strains that were essentially disease resistant, compact, and adaptable to Mexico's different climates. Because of their light insensitivity, these strains could be grown in many parts of the world. Even before this breakthrough, as early as 1957, Borlaug had crossbred strains of wheat that could resist the rust fungus. Production of wheat per acre in his test fields increased from 11.5 bushels to 20. Once Borlaug's crossbreeding reached optimal levels, however, through the increased use of fertilizer and insecticides, particularly dichloro-diphenyl-trichloroethane (DDT), which Paul Mürer had developed in 1939, some farmers got as much as 105 bushels of wheat from an acre.

The Green Revolution, mentioned when Borlaug received the 1970 Nobel Peace Prize on December 10, was now under way, and not only in Mexico: Borlaug's work had implications for the entire world. The world's hungry had cause to hope that their hunger would be al-

LEADING WHEAT-PRODUCING COUNTRIES IN 1994



Note: World total for 1994 was approximately 528 million metric tons.

Source: U.S. Department of Commerce, *Statistical Abstract of the United States, 1996, 1996.*

leviated. Borlaug had to some extent defeated—or at least forestalled—Malthusianism.

SIGNIFICANCE

Hunger is not merely a result of low food production. Many other elements, most notably distribution, enter into alleviating hunger, particularly in developing countries where sometimes-impenetrable bureaucracies make change difficult. In 1961, when Mexican farmers were able to plant Borlaug's considerably improved strain of dwarf wheat seeds, his research group, renamed the International Center for Maize and Wheat Improvement, began to gain worldwide recognition. Borlaug visited other developing countries in the hope that he could extend to them his Green Revolution.

Borlaug's expressed desire was to implement his program in countries that faced severe hunger problems and, within one year, to double their production of wheat, a realizable goal in light of the prolific crops his seeds could produce. Borlaug was impatient, because he realized that world hunger could not wait for creaking bureaucracies to implement the kinds of changes that would save human lives and would both restore dignity to human beings and give them the physical strength they needed to be productive and self-reliant. It was at this point that Borlaug realized he had to become a statesman without portfolio. He knew that if he could not budge recalcitrant governmental bureaucracies, human suffering and famine would continue, even though the means of averting it were within easy reach. Even as his efforts in countries such as India and Pakistan were progressing, the International Rice Research Institute in the Philippines was using Borlaug's model to produce semidwarf strains of rice. This research led to the spread of the Green Revolution throughout Southeast Asia. In addition, half a dozen Latin American countries and numerous countries in the Middle East were direct or indirect beneficiaries of Borlaug's programs. Because of them, thousands of humans were saved from the ravages of starvation.

In his acceptance speech when he was awarded the Nobel Peace Prize, Borlaug said that food was the first and most important priority for all human beings. Without it, he contended, social justice was not achievable. He went on to say that world peace was directly related to the alleviation of world hunger. Expressing his faith in the rationality

of human beings, Borlaug noted that providing food for the people of the world was only a first step toward cultivating the sort of environment in which people could live a fruitful existence. Adequate housing, sufficient clothing, good education, rewarding employment, and effective medical care were also vital components of any society in which human beings could live freely and happily. Retired since 1979 from his International Wheat Research and Production Program directorship in Mexico, Borlaug remained active as a faculty member at Texas A&M University. He maintained an appointment as Whiting Professor-at-Large at Cornell and served on many committees connected with world hunger and human rights. He also served as an associate director of the Rockefeller Foundation and in 1983 was appointed a life member of the foundation.

R. Baird Shuman

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■ JANUARY 15, 1971

ASWĀN HIGH DAM IS EXPECTED TO EXPAND EGYPTIAN AGRICULTURE

The centerpiece of Egypt's ten-year development plan and a monument to President Gamal Abdel Nasser's achievements, the Aswān High Dam was built to control annual floods on the Nile River; prevent damage to the floodplain, and to expand agricultural production. It would eventually provide about half of Egypt's power supply and improve river navigation, but these advantages came at a high cost in human relocation and environmental impacts.

ALSO KNOWN AS: Saad al-ʿĀlī

LOCALE: Nile Valley, Egypt

AGRICULTURAL ISSUES: Drought; Ecology and environment; Flooding; Irrigation and water management

KEY FIGURES

Gamal Abdel Nasser (1918-1970), president of Egypt, 1956-1970

Dwight D. Eisenhower (1890-1969), president of the United States, 1953-1961

John Foster Dulles (1888-1959), U.S. secretary of state, 1953-1959

Anwar el-Sadat (1918-1981), president of Egypt, 1970-1981

Nikita S. Khrushchev (1894-1971), general secretary of the Communist Party of the Soviet Union, 1953-1964

Anthony Eden (1897-1977), prime minister of the United Kingdom, 1955-1957

SUMMARY OF EVENT

Located four miles south of the ancient Egyptian city of Aswān, the Saad al-ʿĀlī, or Aswān High Dam, was the centerpiece of President Gamal Abdel Nasser's ten-year economic development plan, launched in 1960. The plan was designed to industrialize and modernize predominantly agricultural Egypt, an impoverished country that during the 1950's had only recently liberated itself from colonialism and the decadent monarchy of King Farouk.

After Nasser, a former army colonel, became president in 1956, he

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Satellite picture of the Aswān High Dam, from which the Nile is flowing north at the top. (NASA)

sought to regain Egypt's primacy in the Arab world, to create the United Arab Republic, and to implement a program of Arab socialism that involved land redistribution and social and economic reform. In addition to augmenting these goals, construction of the Aswān High Dam was intended to stimulate Arab pride and to serve as a testament to Nasser's achievements. Unveiled on January 15, 1971, on Nasser's birthday, the dam's dedicatory plaque thus cited Nasser, who had died only months before, as the "Immortal Leader," as a champion of freedom and of Arab socialism. Nasser earlier had referred to the dam as "our new pyramid."

Nasser's expectations about the dam's impact were grandiose. He predicted that, within ten years of its completion, the dam would pay for itself and that, within the same decade, it would increase Egypt's national income by more than one-third. He believed that water from the dam would allow Egyptians to reclaim 1.3 million acres from desert, to convert another 700,000 acres to perennial irrigation, and to facilitate the harvest of two annual rice crops on still another

700,000 acres. He further anticipated that the dam's hydroelectric plant would produce 10 billion kilowatts of electricity, sufficient to electrify the entire country, and that the huge lake that would emerge behind the dam would create a fishing industry with a haul of between 20,000 and 30,000 tons per year. Most important, the dam would regularize the Nile River's flow, thereby making it predictable, and, by massively curtailing wastage, would ensure Egyptians an abundance of water.

Begun in 1960 and completed in 1970 at an initial cost of \$1 billion, the Aswān High Dam was an immense undertaking; indeed, it was the largest dam of its kind. Built of earth and rock with a clay and cement core that used enough material to build seventeen large pyramids, it stands 375 feet high and is 11,811 feet long. Behind it, Lake Nasser, one of the world's largest artificial lakes, covers more than 2,000 square miles and extends 300 miles to the south, forming a reservoir capable of holding 204 billion cubic yards of water. The lake's creation necessitated the relocation of nearly eighty thousand people, mostly Nubians, to new homes. These people were promised new jobs in the citrus orchards or in the fishing industry that the dam was expected to generate. By subjecting the Nile River, which flowed through one-half the length of Africa, to unprecedented controls, the dam represented a national effort of heroic proportions.

Financing the dam and securing the technical assistance required, however, enmeshed Nasser's Egypt more deeply in the competitive Cold War diplomacy waged between the United States and its allies on one side and the Soviet Union and its bloc of allies and satellites on the other. Under Nasser, Egypt's foreign policy was avowedly neutralist, aimed toward establishing a viable Third World coalition that kept it free of Cold War commitments either to the United States or to the Soviet Union. Although Nasser showed preference for receiving financial aid for the Aswān Dam from the United States and Great Britain, he also wanted to be free to procure arms and to solicit other aid from Soviet satellites such as Czechoslovakia and Poland or from the People's Republic of China, then a Soviet ally.

During the mid-1950's, U.S. president Dwight D. Eisenhower and his secretary of state, John Foster Dulles, in company with British prime minister Anthony Eden, agreed to contribute money toward financing the dam, with further assurances of technical assistance. So-

viet Communist Party chairman Nikita S. Khrushchev simultaneously began making similar overtures to the Egyptians.

From Nasser's viewpoint, the Anglo-American proposals, which the British and American governments refused to channel through the impartial World Bank, seemed to impugn Egypt's independence as well as its neutralist foreign policy. When Nasser persisted in seeking arms from Soviet bloc countries, took the lead in recognizing the People's Republic of China, and appeared to be negotiating for Soviet aid, the United States and Great Britain abruptly withdrew their proposals. Secretary Dulles, a hard-line anticommunist and antineutralist, was influential in this decision, as were U.S. lobbies of cotton growers and pro-Israeli groups. Nasser, outraged by the "odious" manner in which Eisenhower and Dulles had withdrawn U.S. proposals and by what he regarded as gratuitous comments about the Egyptian economy by U.S. officials, immediately negotiated financing and construction of the dam with the Soviets; it was designed and built under the supervision of the Soviets and West Germans.

SIGNIFICANCE

A host of experts, including environmentalists, Nile River experts, and limnologists, testified that the Aswān High Dam spawned a number of severe environmental problems soon after its completion. Flaws in many of the dam builders' initial assumptions proved to be at the root of these environmental difficulties. In normal years before the dam's completion, the Nile annually bore an estimated 30 billion tons of water to the Mediterranean Sea. Through the 1960's, influential experts erroneously argued that this unused water was wasted. In fact, the water was rich in sediments that vastly augmented the aquatic food chain on which Mediterranean marine life depended while maintaining a delicate balance in the sea's salinity. Once the Aswān High Dam trapped these sediments behind it and allowed a clear Nile to flow to the sea, the adverse impact on marine life was quickly felt.

Across the eastern Mediterranean's continental shelf—twelve miles wide and six hundred miles long—organic carbons and plankton reportedly declined by one-third. The area's sardines, which previously accounted for one-fifth of Egypt's fish catch, disappeared, as did crustaceans and other marine life. Furthermore, the salinity of

Aswān High Dam Is Expected to Expand Agriculture



The importance of the Nile's silt to agriculture in Lower Egypt is illustrated in this early twentieth century photograph showing Egyptian women carrying muddy water from the Nile to fertilize farm land. Completion of the Aswān High Dam retarded the natural flow of silt enough to damage agriculture severely. (Library of Congress)

the Mediterranean Sea rose markedly, as saline waters from the Red Sea, feeding into the Mediterranean through the Suez Canal, were no longer counteracted by relatively sweet Nile waters. The long-term damage to the area's plant and animal life, some experts subsequently warned, could prove disastrous.

When the Nile flooded in normal years before 1971, it deposited about 130 million tons of enriched silts along the Nile Valley, converting the land within its limits into one of the world's most productive agricultural areas. The Aswān High Dam was intended to halt such flooding and trap the river's rich sediments behind it in Lake Nasser. In turn, as the sediments sank into the lake, they were expected to seal the porous Nubian sandstone beneath and prevent the loss of water through seepage. However, the sediments sank in the lake's middle. The lake's water—an estimated fifteen million cubic meters annually—thus began seeping through its three hundred-mile-long sides into underground rock capable of absorbing unlimited quantities of water.

Because Lake Nasser was created in one of the earth's hottest and driest regions, Aswān planners had anticipated a high rate of evaporation, about ten billion cubic meters yearly; however, they failed to

recognize the significance of evaporation resulting from high wind velocities. The Egyptian Meteorological Institute calculated in 1974 that high winds brought evaporation losses up to fifteen billion cubic meters per year, or one-half of the total amount planners had feared was being wasted by leaving the Nile to flow relatively unchecked into the sea. A high rate of evaporation further increased the salinity of the lake and surrounding lands—lands whose salts in the time before the dam would have been scoured away by Nile floods.

The large Nile Delta, the existence of which depended on the river's annual deposits along its two 135-mile mouths, also began suffering several ecological effects from the shutoff of sediments. The delta began shrinking, a process accelerated by the erosive effects of the Mediterranean's powerful west-to-east currents. By the mid-1970's, the delta coastline in several places was retreating up to several hundred yards per year. Because the sediment-free Nile also flowed more swiftly than before, it, too, ravaged delta lands, scouring portions of the riverbed as well.

North of the dam, the river's silt-free flow also undermined older barrier dams and undercut 550 bridges, all of which had been constructed after 1952 as part of Egypt's modernization efforts. By the mid-1970's, in an effort to rectify this situation, the Egyptian Ministry of the High Dam was forced to draft plans for construction of ten new barrier dams at an estimated cost of \$250 million, or one-fourth of the cost of the Aswān High Dam itself.

A decade after its dedication, the dam seemed to have caused or aggravated a host of additional environmental problems that resulted in fresh disappointments and new hardships for the peoples of a crowded, developing nation. The millions of acres that Nasser had hoped to reclaim for agriculture through use of lake and river waters were not realized until the early twenty-first century. Deprived of the Nile's rich sediments, these and most of the remainder of Egypt's six million cultivated acres became dependent on artificial fertilizers, the bulk of which had to be imported.

Cultivated lands in the delta and many other parts of northern Egypt were rapidly being lost as soils became waterlogged and too salty for crops. However, nearly 700,000 acres were brought under irrigation, thereby allowing double cropping, but irrigation rapidly increased soil salinity. Irrigation likewise dramatically increased the in-

cidence of the disease schistosomiasis. Water snails hosting the parasite responsible for the deadly disease proliferated in sluggish irrigation channels, and the incidence of schistosomiasis had risen by 80 percent by the end of the 1970's. (With the use of a new drug to combat the disease during the 1980's, the incidence began to decline.)

During the mid-1970's, evaporation and seepage continued to prevent Lake Nasser from filling to the necessary minimum levels, and Abdel Goher, Egypt's leading limnologist, suggested that it might take two hundred years for the lake to do so. Consequently, only two of the dam's huge turbines were operative much of the time. Moreover, few of the Nubians who were relocated when the lake was forming returned to its shores. A decade later, only about three thousand people attempted fishing there, because crocodiles, scorpions, and wolves fleeing from slowly rising waters made work on the lake too hazardous.

Despite these environmental setbacks, the dam has successfully protected lives and land from flooding and drought. The dam has also generated much-needed electricity for the developing nation. When the dam reached its first peak output, it produced half of Egypt's electricity. However, by the beginning of the twenty-first century, the dam provided less than one-fifth of the nation's power. Its twelve generators can produce up to ten billion kilowatt-hours annually. Although the Aswān High Dam has failed to meet Nasser's goals for Egyptian agriculture, it has had an overall positive impact on Egypt's economy and has also served as a symbol of African and Arab pride.

Clifton K. Yearley

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■ DECEMBER 27, 1971

FUNGICIDE-TAINTED GRAIN POISONS THOUSANDS OF IRAQIS

The Iraqi mercury poisonings were among the worst in a series of poisonings resulting from agricultural products treated with mercury. After the Iraqi epidemic, the U.S. Environmental Protection Agency announced that all pesticide uses of mercury should cease.

LOCALE: Iraq

AGRICULTURAL ISSUES: Ecology and environment; Disease and health issues; Drought; Pests and pesticides

KEY FIGURES

T. W. Clarkson (fl. late twentieth century), chair of the Department of Environmental Medicine, University of Rochester

Gaylord Nelson (1916-2005), U.S. senator from Wisconsin who coauthored the Nelson-Hart Amendment to the Pesticide Act of 1971

SUMMARY OF EVENT

The clinical symptoms of mercury poisoning in human beings were diagnosed and described as early as 1533. It was known that mercury could be absorbed through the skin and lungs and that it could be ingested; the mercury then traveled through the body and accumulated in the tissues of the brain and other vital organs. Although its toxic nature was recognized, mercury was used therapeutically to combat illnesses such as syphilis. Inorganic mercury poisoning became an increasing problem once humans entered the industrial age, when it began to be used routinely in the processing of many materials. The use of organic mercury compounds increased dramatically in the second half of the twentieth century in both industry and agriculture.

Conservationists in Sweden were the first to raise the alarm and report that birds exposed to agricultural materials treated with mercury were dying in large numbers. In Minamata, Japan, eleven peo-

ple were killed or severely disabled between 1953 and 1960 from the effects of mercury poisoning; in 1965, five more people died. (These statistics did not reflect teratogenic effects, colloquially called birth defects.) Both Japan and Sweden ensured the removal of mercury from agricultural products in their countries and monitored the release of inorganic and organic mercuries from industry. Between 1964 and 1969, the mercury used in Sweden as seed treatment and for other agricultural uses declined by 70 percent.

From the 1950's to the 1970's, alkyl mercury fungicides were used routinely to treat seeds for the prevention of crop disease. When Iraqi peasants consumed, rather than planted, treated seed grain exported to Iraq that had been ordered by the Iraqi government, many were poisoned; in 1956 and 1960, there were estimates of 350 poisoned and thirty-six dead. These incidents did not prevent a similar, even more serious epidemic in early 1971.

Identification of the problem in Iraq was complicated by the fact that there was often a considerable time lapse between government distribution of the grain and its consumption in the form of bread. Moreover, because mercury accumulates in the body, weeks or months may elapse before symptoms appear. Many farmers had tested the grain initially on chickens, sheep, or goats and concluded that the grain was safe when they saw no immediate adverse effects.

In 1967, the World Health Organization indicated that studies of mercury in human consumables and human tissue were urgently needed, as it was impossible to set meaningful limits for dietary intake of mercury without appropriate data. It had been documented, however, that mercury poisoning was essentially irreversible. After being exposed to or ingesting mercury, humans and other animals have no symptoms while the deadly compound gradually accumulates. The first symptoms may be minor emotional disorders such as depression and excitability, as well as headaches, fatigue, decreased physical coordination, and loss of memory. Eventually, mercury poisoning causes brain and nerve damage and may lead to blindness, loss of muscle control, advanced senility, and even death. Mercury can also produce extreme teratogenic effects, as it readily crosses the placenta; it may even be passed to infants in the mother's breast milk. Mercury has also been documented to have serious consequences for aquatic, bird, and rodent populations.

In the United States, courts had suspended interstate shipment of treated seed grain, but manufacturers were permitted to dispose of warehouse stocks by export or by intrastate sales. In 1970, the Iraqi government negotiated a trade agreement with one of the international subsidiaries of Cargill Incorporated of Minneapolis, Minnesota, for a shipment of 73,201 metric tons of treated seed wheat and 22,262 metric tons of treated seed barley. It was later documented that the barley originated in the United States; the exact source of the wheat—whether from the United States, Canada, or Mexico—was disputed. The treated grain was dyed red as a warning and labeled in either English or Spanish with the word “poison” as well as with the emblem of a skull and crossbones.

The conditions that led to the tragedy in Iraq included the fact that most of the people involved—the peasants of Iraq—were illiterate sharecroppers who struggled with the burdens of low crop yields, primitive agricultural methods, abused soils, and chronic debt to the landowner. These people lived in extreme poverty, with very little knowledge of the outside world and with little or no access to medical facilities. Winter barley and wheat were the major crops for these people. The Iraqi government had arranged to have grains shipped from the United States because a prolonged drought in the country had caused severe famine. The effects of the drought were all the more severe as three-fifths of the country was not suited to agriculture to begin with.

The imported grain began to arrive in Iraq in October, 1971, but was not fully distributed until January, 1972. After distributing the grain, the Iraqi government broadcast radio warnings to people not to consume the grain; these warnings were either ignored or not received. Birds that ate grain lying on the ground died in large numbers. The peasants nevertheless fed the grain to their animals and ate it themselves. The animals, most of which were fed the barley, soon began to die, and because their meat was contaminated with mercury, sales from rural slaughterhouses were banned. When the Iraqi government established the death penalty for anyone convicted of selling the contaminated seed, some frightened peasants dumped seed in the Tigris River, which resulted in a ban on sales of local fish. Only about five thousand tons of the mercury-treated grain were ever recalled.

The treated grain contained approximately 6.7 parts per million of alkyl mercury fungicide. Each loaf of bread made from the grain contained an estimated 1.2 milligrams of mercury. With the average Iraqi consuming three loaves of bread daily, each individual accumulated mercury at a rate of 3.6 milligrams per day. Swedish and Japanese scientific literature indicated that the first symptoms of poisoning appear once the body has accumulated 30 milligrams of mercury. Other studies indicated that it would require as much as 100 milligrams before symptoms appeared. In Iraq, the ingestion of large amounts of bread occurred over a six-month period because supplies of other foods were generally lacking. A thousand tons of wheat contained enough alkyl mercury to poison sixty thousand people.

By December 27, 1971, fifty cases of mercury poisoning had been recognized in Iraq. By January, 1972, the Iraqi Ministry of Health reported four hundred hospital admissions each day. Following the beginning of the epidemic, the Iraqi government imposed a news blackout. Tourists in Iraq reported thousands of people with brain damage, blindness, and paralysis. Unofficial estimates reported that as many as 60,000 peasants could have consumed enough of the treated grain to have suffered damage. Official tolls eventually reported that a total of 6,530 victims were hospitalized and that 459 died, of whom 34 percent were under the age of ten. All the reported cases were in rural areas; in urban areas the baking of bread was under government control.

SIGNIFICANCE

After the poisoning epidemic, T. W. Clarkson, chair of the Department of Environmental Medicine at the University of Rochester in New York, was invited to conduct research in Iraq with a polystyrene sulfhydryl resin (17-B) that was thought to bind ingested mercury and increase the rate of its excretion. The resin was never intended to be a cure, but it was hoped that it would help pregnant women flush the mercury out of their systems before it could be transmitted to developing fetuses. Clarkson initially arrived with only enough resin to treat two people, but Dow Chemical eventually donated an additional one hundred pounds, and the Food and Drug Administration granted a permit to administer experimental doses. Some progress

was made in the treatment and rehabilitation of surviving patients, but most of the resin arrived after the alkyl mercury damage had been done.

In the United States, the toxic effects of mercury were well recognized by the 1960's and resulted in a legislative initiative to remove alkyl mercurials as seed treatments and to restrict the agricultural use of mercury. The use of mercury in the United States declined by 10 percent in 1968, by 22 percent in 1969, and by 33 percent in 1970. The agricultural use of mercury in Canada declined from 18 percent of the total mercury consumed worldwide in 1964 to approximately 3 percent in 1970. On March 9, 1970, the Pesticides Regulation Division of the U.S. Department of Agriculture (USDA) issued PR Notice 70-7, which suspended registration for all alkyl mercury compounds used in seed treatment. The notice specifically stated that mercury compounds cause irreversible injury to the nervous system. Materials already produced, however, were not recalled, nor did the proclamation cover exports. Sweden also continued to export alkyl mercury fungicides and grain treated with these materials even after it had banned their use within the country in 1966. Shipments to Iraq in 1971 were clearly made by persons aware of the toxic potential of the seed treatments.

Even before the Iraqi epidemic, there had been many incidents worldwide of severe poisonings from mercury compounds used in agricultural products. In 1967, more than 144 persons were poisoned and 20 died from eating mercury-contaminated corn in Ghana. In 1965, 45 people became ill and 20 died from ingesting mercury-coated seed in Guatemala. In West Pakistan in 1961, 100 people were poisoned. Fatalities among farmers using alkyl mercury-treated seeds in Sweden occurred in 1929, 1932, 1949, and 1954. Concerned citizens and scientists had recorded dramatic effects of mercury on birds, including bird deaths, refusal to nest, abandonment of nests before the eggs hatched, rotten eggs, and declines in common species of birds.

In 1969, three children in a New Mexico family were permanently injured by ingesting pork fed with mercury-treated corn. The corn, although dyed red and labeled poisonous with a skull and crossbones, had been fed to hogs belonging to the family. The story was released on television by the National Broadcasting Company on Feb-

ruary 17, 1970. One day later, the USDA suspended the mercury fungicide registration of the manufacturer of the seed. Although mercury use in the United States declined by one-third from 1969 to 1970, exports increased in that year. Experts warned that countries with large, illiterate peasant populations would have difficulties with warnings such as labels and dyes. If animals fed the treated grain did not die, peasants often washed off the dye, assuming they were thus removing the danger. Some suggested that a different dye be added to the grain to give it an unpleasant taste and render it inedible. Others advised that the warnings be written in the language of the country to which the grain was shipped.

After the Iraqi epidemic, on March 22, 1972, the U.S. Environmental Protection Agency announced that all pesticide uses of mercury should cease because they represented a hazard. In June, 1972, Gaylord Nelson, a Democratic senator from Wisconsin, addressed the Senate Commerce Committee on the Environment and raised the moral issue of whether the United States should allow the exportation of products judged too hazardous for domestic use. Nelson demanded that the Constitution be amended to ensure that the people of the United States have the right to a decent environment protected by the government.

The fact that the poisoning incident occurred in a foreign country reflected the prevalent U.S. attitude toward the manufacture, control, and distribution of dangerous pesticides. The Nelson-Hart Amendment to the Pesticide Act of 1971 required that foreign governments be notified of the potential toxic effects of pesticides being shipped to them. If those governments elected to have pesticide-treated products or pesticides shipped to their countries, they were required to sign waivers. Notification of the shipments would be made to the United Nations and other international organizations.

Michele Barker-Bridgers

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■ 1972

AFL-CIO RECOGNIZES THE UNITED FARM WORKERS

The AFL-CIO's formal recognition of the United Farm Workers as a labor union marked the rise of a major organization fighting for workers' rights.

LOCALE: Salinas Valley, California

AGRICULTURAL ISSUES: Labor

KEY FIGURES

César Chávez (1927-1993), leader of the United Farm Workers of America

Bud Antle (1914-1972), major lettuce grower in California's Salinas Valley

Bill Grami (fl. late twentieth century), official of the Western Conference of Teamsters

SUMMARY OF EVENT

The success of strikes and worker organization during the 1960's in the San Joaquin Valley in California inspired farmworkers to organize in the Salinas and Santa Maria Valleys, where 70 percent of all the head lettuce harvested in the United States was grown. Many of the nation's strawberries, broccoli, cauliflower, tomatoes, carrots, artichokes, celery, garlic, and other vegetables were also grown in this area. In 1970, after 140 grape growers signed contracts with the United Farm Workers Organizing Committee (UFWOC), lettuce growers were faced with demands for union recognition of elections, in which the UFWOC appeared to be the certain winner. Growers had to choose between signing the agreement and facing the same type of farmworker strategies that had proved successful in Delano. Growers elected to bypass the elections and negotiate with the Teamsters Union. This strategy, utilized successfully in 1961 by one of Salinas's largest lettuce growers, Bud Antle, when he signed a contract with the Teamsters, allowed growers to avoid the more stringent demands by the Agricultural Workers Organizing Committee (AWOC).



Migrant farm workers tending grape vines. (©Don Mace/Dreamstime.com)

A 1972 agreement between the farmworkers and the AFL-CIO (American Federation of Labor and Congress of Industrial Organizations) provided members of UFWOC with official recognition and a crucial ally in their struggles with the Teamsters.

By 1970, California field-workers were organized and threatening strikes and boycotts. This created an unstable flow of produce handled by truck drivers, cannery workers, and other Teamster members. At this point, Teamster officials wanted representation rights that would allow them to control the field-workers. Since the 1930's, the Teamsters had had jurisdiction over those field-workers who drove trucks, operated field conveyors, and pulled shed trailers with tractors. The Teamsters were aware that UFWOC would protest any moves in this direction as a violation of the 1967 jurisdictional agreement made in Delano with UFWOC. The result would likely be demands for elections, and a vote in favor of UFWOC would demonstrate that the Teamsters did not represent the field-workers.

July, 1970, is a crucial date in the escalation of conflict between growers and the UFWOC. Several vegetable growers approached Western Conference of Teamsters official Bill Grami during new contract negotiations with Teamster truck drivers. The growers wanted Teamsters to expand their representation to include field-workers.



César Chávez at a Miami, Florida, news conference in March, 1972, after the United Farm Workers won a labor agreement for citrus harvesters. (AP/Wide World Photos)

When truckers called a strike, the Teamsters found a reason for expanding representation to include field-workers when truckers decided to remain off work until contracts were also granted to field-workers. Grami responded that Teamsters had received numerous informal requests from field-workers for Teamster representation.

Following grower ratification of a new truckers' contract, it was also agreed that the Western Conference of Teamsters would be allowed and encouraged to recruit farmworkers. Shortly thereafter, nearly all of the 170 growers in the area announced that they had signed Teamster agreements. Under terms of the agreement between the Teamsters and growers, workers would be required to join the Teamsters and pay \$1.25 a week in dues. The agreement included pay raises of ten to fifteen cents an hour and minimal health and welfare benefits. The union hiring hall, utilized by farmworkers to staff the fields, was eliminated by the agreement giving growers freedom to hire workers.

The grower-Teamster agreement came one day after UFWOC leader César Chávez announced an organizing drive aimed at the vegetable fields. Chávez reacted to the grower agreement and marched into Salinas with several hundred farmworkers and an AFL-CIO contingent headed by organizing director Bill Kircher. One grower was picketed after firing 250 workers for not joining the Teamsters. UFWOC also began preparing legal action and a nationwide lettuce boycott.

Teamsters at the national level favored conciliatory action. The Auto Workers Union, a close ally of UFWOC, pressured national Teamsters leaders to help resolve the conflict. The Western Conference of Teamsters was asked to arrange a treaty with UFWOC, with assistance from the bishops' committee, which had been instrumental in the vineyard settlement. This settlement reallocated jurisdiction over field-workers to UFWOC and stipulated that the growers who had recently signed Teamster contracts could switch to UFWOC. However, growers refused to give up Teamster contracts, and Grami claimed that the treaty bound both unions to honor the growers' wishes. After two weeks of attempts by UFWOC and the bishops' committee to get the growers to relent, a strike was called. Hundreds of UFWOC members and supporters picketed in front of targeted farms around Salinas and held outdoor rallies highlighted by emotional speeches. Growers countered by going to court for a restraining order against picketing, while the Monterey County Board of Supervisors in Salinas adopted an antinoise ordinance that prohibited UFWOC from using any voice-amplifying equipment. Despite dozens of arrests, pickets ignored these orders.

The California Supreme Court overturned rulings by the Monterey County Superior Court and ruled that there could be one informational picket at each of twenty-two of the Salinas Valley farms that constituted the strikers' prime targets. UFWOC was refused the right to call a boycott against any of the 170 growers holding Teamster contracts. UFWOC ignored the ruling and called a boycott that focused on food markets in sixty-four U.S. cities. This boycott was difficult, because lettuce is a staple and growers waged a strong counter-attack. Antle, for example, persuaded another superior court judge that UFWOC's actions against his firm violated the state's Jurisdictional Strike Act and UFWOC's treaty with the Teamsters. In a favor-

able ruling for the growers, Judge Gordon Campbell ordered the arrest of Chávez. This event intensified support for UFWOC and Chávez. More than two thousand UFWOC members and supporters, including Ethel Kennedy and Coretta Scott King, accompanied Chávez to the jailhouse. They initiated prayer vigils and highly publicized demonstrations. Three days before Christmas, the judge ordered the release of Chávez.

The boycott continued into the early months of 1971, while national Teamster leaders and a bishops' committee continued unsuccessful attempts to persuade growers to sign UFWOC contracts. The greatest conflict was over the hiring hall, which was a crucial method for granting the union the authority promised by the vineyard contracts. Growers did not like the workers sent out by the halls, complaining that dispatchers sent out older workers, whose seniority gave them priority, rather than the faster young workers requested by the growers.

AFL-CIO leaders agreed in 1972 to grant Chávez a charter that formally recognized the Organizing Committee as a union. UFWOC became a full-fledged affiliate of the AFL-CIO and was renamed the United Farm Workers of America (UFW).

SIGNIFICANCE

This agreement gave the organization official standing, a role in AFL-CIO decisions and operations, and a sense of stability, but it did not abate the conflict between the grower-Teamster coalition and the UFW. In January, 1973, the Teamsters went after the UFW's grape contracts. Teamster organizers went through the fields to get signatures on petitions asking the growers to sign up with their union. Nine hours after the UFW contract expired, Teamster and grower representatives announced they had negotiated contracts covering virtually all of the Coachella Valley's vineyards. The Teamsters would eliminate the union hiring hall through the contracts and sign agreements with labor contractors to help supply workers.

The conflict between farmworkers and growers increased during the early 1970's. This period was characterized by increasingly violent strikes among Teamsters and UFW supporters. California's efforts at legislating a solution to the conflict were largely unsuccessful. The UFW was able to survive in part because of their formal agreement

with the AFL-CIO, which continued to support them with financing and staff. From 1975 to 1980, more than five hundred elections were held in the fields of California, the majority won by the UFW. Finally, in March, 1977, Chávez and the Teamsters president Frank Fitzsimmons agreed that UFW would represent all farmworkers.

Gregory Freeland

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■ 1972-1973

WORLDWIDE DROUGHTS BRING AGRICULTURAL FAILURES AND FAMINE

During 1972 and 1973, many regions of the world experienced one of the most severe droughts of the century. Particularly severe conditions affected the Sahel of northern Africa south of the Sahara, the Soviet Union, India, China, Australia, and Amazonia. Some areas experienced famine, hunger, and starvation, whereas others suffered only crop shortages but had to import foodstuffs, causing prices to rise worldwide.

LOCALE: Africa; Asia; South America

AGRICULTURAL ISSUES: Climate change; Drought; Famine and hunger; International food relief

KEY FIGURES

Reid A. Bryson (1920-2008), atmospheric scientist at the University of Wisconsin who studied the causes and characteristics of drought in many parts of the world

Michael Glantz (fl. late twentieth century), scientist in the Environmental and Societal Impacts Group at the National Center for Atmospheric Research who studied the drought in the Sahel

Stephen Henry Schneider (b. 1945), climatologist who specialized in theoretical investigations of climatic changes arising from natural and human-made causes

SUMMARY OF EVENT

Drought is difficult to define, as are its specific causes. In general, a region that experiences subnormal precipitation over an unspecified period of time can be said to be suffering from drought. The events that caused the global drought of 1972-1973 occurred throughout the world and resulted in changes to the physical environment, especially the atmosphere, brought about by both natural and human actions. Areas most prone to drought are desert rims and semiarid steppe regions. Precipitation in these areas is unreliable, and even small changes in precipitation can initiate a drought.

Several conditions were cited as causal factors of drought during the early 1970's. These included a change in the seasonal position of the Intertropical Convergence Zone (ITCZ) and subtropical highs, a change in summer monsoonal circulation, displacement of midlatitude storm tracks caused by expansion of circumpolar westerly winds into lower latitudes and the development of persistent blocking systems in the middle latitudes, and an El Niño-Southern Oscillation event along with the inhibition of cold, upwelling coastal waters.

Studies of the atmospheric circulation showed the existence of two basic climatic regimes that affect the location of the ITCZ and of subtropical highs. The Hadley regime dominates between the equator and about 30 degrees latitude. This area is characterized by air rising at the equator, where surface trade winds converge, and forming a low-pressure system, the ITCZ. The rising air above the ITCZ flows poleward until it is caught in the circumpolar westerlies. Here, at 30 degrees latitude, the air builds up and subsides, forming the subtropical high pressure belt in both hemispheres.

Poleward of the Hadley regime, the Rossby regime dominates. This regime is marked by a zonal (west-to-east) flow of air resulting in variable weather brought on by alternating passage of transient high- and low-pressure cells. The changes are related to air currents above that are essentially a global zonal flow of air in which undulations occur that are called Rossby waves. The Rossby waves undergo a consistent cyclic change from zonal flow (west to east) to meridional flow (north to south or south to north) and back to zonal. The leading edge of these upper air waves is characterized by a stream of rapidly moving air known as the jet stream.

The southern area of the Rossby regime borders on the subtropical highs that result from subsiding air in the Hadley regime. The highs thus form the junction between the two regimes; the locations of the highs are determined by the temperature gradient between the equator and the poles. These highs restrict precipitation when they are in place.

During the winter, the polar areas are extremely cold, whereas the tropical temperatures vary little from the warm season to winter. As a result, the temperature gradient between the equator and the poles is greatest during winter. The Rossby regime consequently dominates

in winter and pushes the Hadley regime, with its subtropical highs, further toward the equator over the drought-sensitive areas.

In the summer, the temperature gradient is less than in the winter, so the Rossby regime migrates poleward. The subtropical highs and the ITCZ also migrate poleward. The significance of these migrations is the location of the junction between the two regimes. When the subtropical highs move poleward, the ITCZ moves poleward as well. Thus the position of the subtropical highs determines the poleward extent of the rain-bearing ITCZ. A one-third-degree equatorward change (thirty-six kilometers) in the Atlantic High has been known to cause a latitudinal change of one degree of latitude of the ITCZ.

Vertical temperature gradients are also known to have an effect on the location of the ITCZ. Studies indicated that a 0.06-degree increase in temperature per kilometer can also cause a one-degree shift in the ITCZ. Pollution, in the form of carbon dioxide in the atmosphere, enhances the greenhouse effect as the quantity of this gas increases and temperatures in the industrial middle latitudes also rise. It was thought likely that carbon dioxide affects only temperatures near Earth's surface, not those aloft. A change in surface heating affects the vertical temperature gradient, however, which in turn influences the location of the subtropical highs.

Pollution in the form of particles affects the horizontal temperature gradient, which can also affect the position of the ITCZ and subtropical highs. Particles affect temperature by reflecting and scattering incident solar radiation, thereby lowering the surface temperature of Earth. Research showed particle concentration to be greater in high latitudes, which results in a stronger temperature gradient between the equator and the poles in summer. The larger gradient in turn affects the positions of the ITCZ and subtropical highs, much as the winter gradient does.

In areas with monsoons, rainfall is heavy, but it is neither constant nor uniform from one year to the next. After the rainy season, June through September, the remainder of the year is dry. The summer precipitation pattern is divided into active and break phases; an active phase is characterized by cloudy skies and copious rainfall, while the break phase is sunny and hot. Years associated with drought usually correlated with a late onset and early withdrawal of the monsoon, as well as insufficient precipitation during the monsoon, particularly

if break phases were extended. Crop failure, famine, and starvation could follow.

Aloft, midlatitude westerlies on occasion develop an extreme meridional pattern in which large pools of air are cut off from the main zonal circulation. Air rotating clockwise is a blocking high; this high, because of the jet stream around it, resembles the Greek letter omega, which is why it is called an omega block. A block of this type tends to persist for several weeks or even longer, and since block weather is characteristically hot and dry, drought usually follows. The block deflects cool, humid air far poleward of its usual path, so there is no relief from the hot, dry weather.

El Niño is a warm-water current that periodically—usually every three to seven years—flows southward along the coast of Ecuador. It covers the cold, Peruvian current and prevents upwelling of cold water along the coasts of Ecuador and Peru. El Niño is often associated with the Southern Oscillation, a fluctuation of the intertropical atmospheric circulation that moves air between the southeastern Pacific subtropical high and the Indonesian equatorial low. Differences in temperature between the two areas produce a variation of pressure: When pressure is high over the eastern Pacific Ocean, it tends to be low in the eastern Indian Ocean and vice versa.

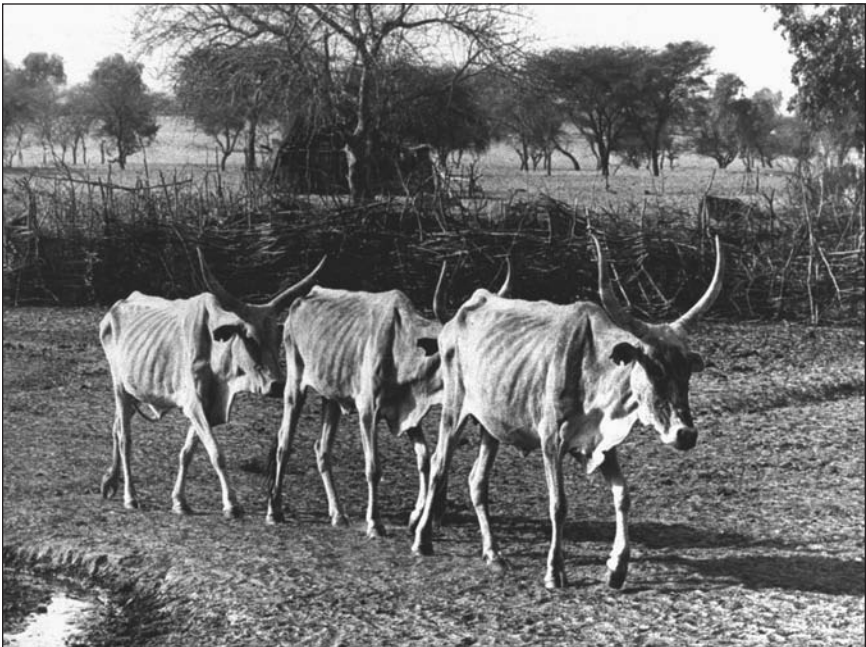
A combination of the Southern Oscillation and El Niño produces what is called an El Niño-Southern Oscillation (ENSO) event. ENSO events occur when prevailing trade winds weaken and the equatorial countercurrent strengthens. This causes warm surface water to reverse course to flow eastward and then south over the cold Peruvian Current. The oscillations between these pressure cells, called Walker circulations, drive the large-scale zonal flow of tropical air and are subject to fluctuations, the most striking of which are an oscillation between high phases (non-ENSO) and low phases (ENSO). The low phase or ENSO event produces subsiding high pressure and decreased precipitation over Amazonia, central Africa, Indonesia, and India. During this phase, low-level westerlies and high-level easterlies dominate the Pacific, and subtropical westerly jet streams in both hemispheres intensify, as does the Pacific Hadley cell. On several occasions, among them during the 1972-1973 period, an extreme ENSO event occurred that intensified those conditions.

Desertification, or desert expansion, along desert peripheries is

one of the human contributions to a drought event. The condition is brought on by overgrazing, which lightens the desert surface and increases the albedo, or reflectance, and results in a decrease of surface temperature. This inhibits convection and reduces precipitation.

SIGNIFICANCE

The area most affected by the 1972-1973 drought was the African Sahel, a stretch of land from Senegal in the west to Ethiopia in the east. The causal factors here included monsoon failure, expansion of circumpolar westerlies inhibiting the northward movement of the rain-bearing ITCZ, global increase in carbon dioxide, and desertification. In 1972-1973, an estimated 100,000 to 200,000 people and as many as four million cattle died. A mass migration of people fled southward, leaving their homes and at times crossing international borders. Many went to urban areas in search of food and work, only to end up in refugee camps. In Ethiopia, Kenya, and Ivory Coast, coffee harvesting was reduced. In Nigeria, ground nuts, sorghum, and



Starving cattle in the drought-stricken Sahel portion of Senegal in 1973. (AP/Wide World Photos)

rice harvests were sharply curtailed. It was also suggested that stresses from famine led to the demise of the imperial regime in Ethiopia. The result of the drought in these areas was catastrophic.

During this period, the Soviet Union also suffered from drought. The cause here was a blocking system, which directed rain-bearing storm systems farther northward than usual. As a result of drought, the 1972 Soviet wheat crop failed, and the country had to import eighteen million tons of wheat from the United States, depleting U.S. grain reserves. Forcing the Soviet Union into the international grain market in this way caused the price of wheat to rise sharply, tripling by 1974. The same blocking systems extended the drought into China, where the harvest was described as disastrously short of expectations.

A failure in the monsoon system brought drought to northern India, resulting in crop failures, particularly the grain crops. Monsoon failure could also be blamed for drier conditions in Australia, where wheat harvests were reduced 25 percent below the previous five-year average.

The drought-prone zone of eastern Brazil, Amazonia, suffered when the ITCZ remained in a northerly position and the more stable air of the south Atlantic dominated. The effects of the strong ENSO event were compounded by a descending branch of the Walker circulation covering most of Amazonia. The result was crop failure, particularly a reduction of the coffee harvest, which caused long-term economic problems for the country. The ENSO event also affected Peru and Ecuador by curtailing upwelling of the cold, nutrient-rich waters along the coast, where the anchovy harvest was ruined. Prior to 1972, Peru had harvested between twelve and fourteen million tons of anchovies every year, but after 1972 the harvest averaged only about two million tons annually.

The Middle East suffered less from drought than most other areas. The yields of wheat—the major crop in this region—were down, but this did not substantially affect the economy, which was based on oil. Perhaps the major impact on this region was the fact that the national leaders realized that oil was not inexhaustible, and that they must be prepared for a time when there was no more oil and another drought occurred.

Long-term effects of the 1972-1973 drought were many. It caused scientists to reassess their interpretation of climate as related to

drought and to make efforts to develop methods for predicting drought to help offset the consequences. Confidence in the Green Revolution decreased because the new crops were found to be more susceptible to climatic change than the more traditional varieties had been. The oil-rich nations with little agriculture gained a new appreciation for climatic threats to world food supply and for the need to diversify and strengthen their economies against the time their oil reserves ran out. The U.S. Agency for International Development (AID) attempted to shorten the response time of international relief organizations and established the Famine Early Warning System (FEWS) to observe crop and vegetation patterns over the Sahel for signs of early drought.

Ralph D. Cross

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■ OCTOBER 21, 1972

U.S. CONGRESS EXPANDS PESTICIDE REGULATIONS

A federal act established to protect farmers was expanded to protect the environment from the effects of toxic chemicals used to protect agricultural crops.

ALSO KNOWN AS: Federal Environmental Pesticide Control Act

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Disease and health issues; Ecology and environment; Government policy and regulation; Pests and pesticides; Scientific research

KEY FIGURES

William D. Ruckelshaus (b. 1932), chief administrator of the Environmental Protection Agency, 1970-1973

John A. Moore (fl. late twentieth century), official of the Environmental Protection Agency who testified before Congress in favor of stricter pesticide regulation

Jay Feldman (b. 1953), national coordinator of the National Coalition Against the Misuse of Pesticides who gave testimony before Congress

SUMMARY OF EVENT

The prosperity and the relative good health of the U.S. population are based in part on the nation's ability not only to grow an abundance of basic crops but also to store harvests effectively. Crop losses resulting from insect activity, fungal infections, and rodent invasion are often as devastating to the human population as is a lack of productivity. Insecticides, fungicides, and rodenticides have been critical to the maintenance of the quantity and quality of grains, fruits, and vegetables produced, stored, and transported in the United States. In addition, pesticides are vital to the protection of wooden homes from termites, clothing from clothes moths, and museum artifacts from a wide array of fungal and insect agents.

The Federal Insecticide, Fungicide, and Rodenticide Act of 1947

*Rachel Carson, whose 1962 book
Silent Spring alerted the general
public to the dangers of widespread
use of chemical pesticides.
(Library of Congress)*



(FIFRA) established basic requirements for the labeling of pesticide products. This act was an attempt to ensure that pesticides were effective as claimed and to protect users, mainly farmers, by requiring that specific safety instructions be posted on product labels.

At the time that FIFRA was enacted, the use of dichloro-diphenyl-trichloroethane (DDT) had prevented repetition of the World War I-era deaths from louse-born typhus and had offered some hope of dramatically reducing malaria worldwide. Increasing numbers of chemical agents, particularly chlorinated hydrocarbon insecticides, were becoming available for farm use. Using chemicals to reduce crop losses was viewed by the general public as hardly different from the use of penicillin to overcome infections. The 1947 act was thus primarily intended to protect the safety of farmers, who were the main applicators of pesticides, and to provide some degree of truth in labeling. The long-term environmental effects of some pesticides that persist in the environment were not well understood until much later, following the 1962 publication of Rachel Carson's *Silent Spring*.

In 1972, the Federal Environmental Pesticide Control Act (FEPCA) made substantial revisions in FIFRA that gave it an environmental dimension. The critical change was the provision that the pesticide, "when used in accordance with widespread and commonly recognized practice will not generally cause unreasonable adverse ef-

fects on the environment.” Such “unreasonable adverse effects” were further defined in the act as “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.” FIFRA was no longer viewed as an act to protect farmers from harm; adverse effects on humans became simply one of many environmental effects.

The 1972 FEPCA revision continued to control pesticide sales by way of label requirements and required the administrator of the Environmental Protection Agency (EPA), formed two years earlier, to consider the environmental impact of the use of pesticides for the uses proposed on the label. This addition expanded FIFRA from an act regulating pesticide use to an environmental protection act by way of controlling the labeling and registration process. In 1972, Congress directed that each pesticide be classified as either “restricted” or “general use.” In addition, specific uses of pesticides could be classified as either “general” or “restricted.”

If used according to the label instructions, general-use pesticides can be applied by anyone, and no additional training or certification is required of the user. A general-use pesticide, however, is often restricted in the sites where it can be used. For example, paradichlorobenzene moth balls are registered for home use, in which a few moth balls are usually isolated in closets and drawers away from people; however, the same chemical is not legal for use in museums, where employees would constantly be working around higher concentrations built up in often-used specimen cabinets.

Restricted-use pesticides may be applied only by certified applicators or persons working under their direct supervision. Pesticides that are highly toxic require specially trained applicators. A pesticide may also be restricted, however, if it persists in the environment for a long period. Common insecticides thus disappeared from store counters because they were too persistent in the environment, because they were found to have adverse health effects, or because they required specialized application gear.

According to FIFRA, the term “pest” encompasses not only insects, rodents, and fungi but also roundworms, weeds, and any other aquatic or terrestrial animal, plant, or microorganism declared by the EPA administrator to be a pest because of its effects on health or the environment. Viruses, bacteria, and other microorganisms on or

in humans or other animals are not considered pests. A pesticide is thus defined as any substance that prevents, repels, or destroys such pests. Pesticides may be chemical or biological substances; a pesticide may be merely considered as active ingredient or may consist of a complex formulation. Attractants, repellents, defoliants, and plant regulators are all pesticides.

The pesticide registrant has specific duties to label the product after it is produced. It is a violation to remove or deface the usage instructions that are required on a pesticide container. If pesticides are purchased in large quantity, the label is to be copied and transferred to the containers to be used in application.

Because the major leverage for regulating pesticides centers on labeling, the contents of the label are set by regulation. The nine items that must appear on the label are the product name, the name of the producer, the net contents, the product registration number, the producer-identifying number, the ingredient statement, exact warning statements, directions for use, and use classifications.

The ingredient statement lists active and inert ingredients of the pesticide, similar to the ingredient labels often seen on food packaging in grocery stores. The warning statement is considerably more complex than the ingredient statement, because a chemical can pose different levels of damage if exposed to skin or eyes, or if inhaled or ingested. Pesticides, therefore, must be extensively evaluated in animal tests to establish levels of 50 percent lethal dosage for skin contact or ingestion (a level known as LD50) or lethal concentration if inhaled (known as LC50). With four levels of toxicity for each of five hazards, a pesticide must be labeled with warnings indicating the highest hazard. The large signal words used to flag the level of danger range from the most dangerous, "poison," to the least alarming, "caution."

All pesticides rated category one poisons must also provide a statement of practical treatment or first aid on the front panel of the product label; products in other categories may print the treatment elsewhere on the label. Warnings of potential hazard to humans and domestic animals must also be included on labels, as must a notice stating if other nontarget organisms are particularly endangered. Because some pesticides are petroleum-based or pressurized, warnings about flammability and danger from explosion may also be required.

The directions for use must include legible and simple instruc-

tions that protect the public from injury and fraud and that avoid adverse effects on the environment. Such directions include site of application, target pests, dosage or rate of application, method of application, frequency of application, and limitations on reentry to the area where the pesticide has been applied. Storage and disposal instructions are particularly critical for preventing environmental contamination. The statement of use classification advertises boldly whether the pesticide is classified for general use or restricted use. This last designation requires a follow-up statement that clearly states that the pesticide is for retail sale only to certified applicators.

Criteria for storage facilities are provided for the most toxic pesticides. Mobile equipment must follow general procedures for decontamination, maintenance, and inspection. Safety precautions are mandated, including both accident-prevention measures and ongoing safety measures for persons working in the distribution and handling of pesticides. For specific highly toxic pesticides, periodic physical examinations, including cholinesterase tests, are required of persons working with pesticides. Fires involving pesticides can present particularly dangerous scenarios, and storage of large quantities of pesticides require the notification of local firefighting personnel to ensure preparedness.

Exemptions from the complex FIFRA regulations are allowed when a pest outbreak occurs posing dramatic economic or health threats and when there is not enough time to seek registration of an appropriate pesticide. With the increasing availability of fast international travel and the rise in pesticide resistance, such problems seem more likely to arise in the future.

Most important, FIFRA established standards for certification of commercial applicators for the use of restricted pesticides. The testing of an applicator's competence is based on problems and situations relevant to the applicator's certification. In addition to the use of the pesticide in various formulations, certified applicators must be knowledgeable about the label data, safety procedures, environmental concerns, and laws and regulations relating to the pesticide being used. There are provisions for experimental-use permits for the purpose of gathering data on new pesticide formulations and applications.

Minor amendments to the act were made in 1975, but in 1978 the

Federal Pesticide Act changed FIFRA considerably, establishing a generic registration procedure that required a standardized evaluation of the benefits and risks of active ingredients of pesticide products. The prior act had required registration of each chemical based on its brand name; however, the same chemical is often marketed under many brand names.

Additional extensive amendments in 1988 fine-tuned procedures for registration of pesticides and for canceling or removing pesticide registrations. The 1988 amendments empowered the EPA to set deadlines for manufacturers to reregister pesticides containing newly regulated ingredients. A fee based on market factors was also assessed pesticide applicants to help underwrite a portion of the cost of reviewing pesticide reapplications.

Congress authorized the use of a scientific advisory panel to assist the EPA in evaluating and regulating pesticides. Subpanels of this group review major scientific studies relevant to pesticides and consult in the reclassification of pesticides. It is sometimes necessary to take immediate action when new research reveals that a pesticide has unexpected harmful effects. The EPA administrator can promptly suspend or change registration on a pesticide; this is called an emergency suspension action. Any emergency suspension, however, requires an immediate peer review. In cases in which such an action leaves a registrant holding a large quantity of pesticide, the administrator is authorized to compensate the registrant for the loss.

Procedures exist for the recall of pesticides determined by the EPA to be more hazardous than first recognized. In such cases, producers must notify the EPA administrator of the location and the amount of the canceled or suspended pesticide. Pesticide containers and rinsing agents are also regulated, and penalties for falsifying records or data submitted in support of applications are defined in the act.

SIGNIFICANCE

FIFRA, FEPCA, and their amendments provided uniform criteria for pesticide regulation on a nationwide scale. The responsibility for registering a pesticide is with the manufacturer, not with the user. No person in any state may sell, ship, or receive any pesticide that is not registered with the EPA, regardless of whether the activity is carried out within a state or across state lines. (There are provisions allowing

a manufacturer to transport a nonregistered pesticide for disposal when it has been canceled or while it is in an experimental stage of development.) States retain the right to register pesticides in each state, and a state may impose more stringent restrictions. States may not, however, allow sale or use of a pesticide if the pesticide is prohibited under the law.

The act directs enforcement power to the EPA. For those states that hold a cooperative agreement with the EPA, the state assumes primary enforcement responsibility. Provisions of these acts allow the administering government agency to seek both criminal and civil sanctions against companies, individuals, and organizations that violate provisions of the law. The EPA may inspect for violations, issue orders to require compliance, and seek court injunctions to require compliance. Knowingly violating provisions of the law is a misdemeanor.

Examples of violations include failure to submit required information, falsification of records, and failure to observe the various orders canceling or suspending pesticide use. Individuals who advise pesticide applicators to use illegal pesticides are considered to be in violation of the law. It is also unlawful to use any registered pesticide in a manner inconsistent with its label, although it is legal to dilute pesticides to lower concentrations or to use them against alternative pests or by other methods of applications if such uses are not specifically prohibited. As with any system that must deal with the complexity of the environment and the limitations in scientific knowledge, however, the enforcement of these laws is open to considerable prosecutorial discretion.

Passage of FIFRA and its amendments was a response to the real need for effective insecticides, fungicides, and rodenticides as well as to the need to protect the populace and the environment from the damaging effects of toxic and long-lasting chemicals. The law mandates the use of the current expertise of the scientific community to maintain a fair and reliable system of regulation for the pesticide industry.

John Richard Schrock

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SEE ALSO: 1917: American Farmers Increase Insecticide Use; 1939: Müller Discovers Insecticidal Properties of DDT; 1964: High-Yield Rice Fosters Green Revolution; November 20, 1969-December 31, 1972: DDT Ban Signals New Environmental Awareness; July 10, 1981: Brown Orders Medfly Spraying in California.

■ 1974

WORLDWATCH INSTITUTE IS FOUNDED TO PROTECT ENVIRONMENT

Worldwatch Institute was founded to keep policy makers in Washington and around the world aware of global environmental concerns, particularly in regard to government agricultural policies.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Ecology and environment; Government policy and regulation

KEY FIGURES

Lester Brown (b. 1934), agricultural expert who established the Worldwatch Institute

Orville L. Freeman (1918-2003), former governor of Minnesota and U.S. secretary of agriculture who served as chair of the board of directors of Worldwatch Institute

Denis Hayes (b. 1944), executive director of Earth Day, 1970, who served as a Worldwatch Institute researcher and writer, 1975-1979

SUMMARY OF EVENT

Inspired by an idea suggested by Lester Brown, the Worldwatch Institute was incorporated in 1974 and began operations in 1975. Brown's particular concerns were population, food supply, soil erosion, and creating policies that would curb the most serious environmental abuses. By locating the institute in Washington, D.C., Brown hoped that Worldwatch could influence politicians and members of government agencies in the United States and abroad. The Washington, D.C., locale also offered the prospect of gaining support from high-powered individuals and foundations. Worldwatch would provide a place where people concerned about the global environment could exchange ideas and develop strategies to meet what seemed to many people to be an impending environmental crisis. Brown believed that the institute would provide a breeding ground for solutions to environmental problems.

LESTER BROWN

The idea for the Worldwatch Institute came from Lester Brown, a forty-year-old American who had established himself as an international expert on soil, agriculture, and food supplies. Brown had spent his early years working on a family farm in the Midwest and had gone on to earn degrees in agriculture and agricultural economics from Rutgers University and the University of Maryland. In 1959, he joined the U.S. Department of Agriculture (USDA), where his interest in worldwide agricultural issues intensified. Under the auspices of the USDA, he published a number of influential reports that confirmed his expanding expertise on global agriculture and food production.

During the 1960's, Brown worked with the International Agricultural Development Service and in 1969 became a senior fellow in the Overseas Development Council (ODC). It was during these years that Brown formulated his idea for a Worldwatch Institute that would present an interdisciplinary approach in confronting matters relating to the human environment.

When the institute was created, it was decided that it should be governed by an international board of directors with Orville L. Freeman serving as its chairman. A former governor of Minnesota and the U.S. secretary of agriculture from 1961 to 1969, Freeman had a background in agriculture similar to Brown's, and he shared Brown's concerns about the consequences of continued abuse of the land. Freeman gave strong encouragement to Brown while he served in the U.S. Department of Agriculture. The board of directors agreed that Brown would be president of the institute and generally gave him complete freedom to manage Worldwatch as he wished. From the beginning, the Worldwatch Institute received generous funding from several foundations, including the Kettering Foundation and the Rockefeller Brothers Fund, the United Nations, various U.S. government departments, and private individuals.

Offices for the institute were established across the street from the Overseas Development council (ODC), where Brown had worked for four years. *Science* magazine (March, 1975) described the institute as a think tank aimed at alerting the world to impending problems arising from inattention to the depletion of natural resources. Brown in-

tended that the institute would remain manageable, and to ensure this goal, he insisted that the staff never exceed twenty. His initial associates included Eric Eckholm, who had worked closely with Brown at ODC; Denis Hayes, a well-known Washington environmentalist; and James Fallows, a staff writer for *Washington Monthly* and later a speechwriter for President Jimmy Carter.

Almost immediately, Worldwatch began to issue pamphlets on a wide range of topics. This was in keeping with Brown's view of himself as a synthesizer and the institute's stated goal of taking a multidisciplinary approach to matters relating to the human environment. The immediate objective set by Brown was to redefine national security in nonmilitary terms. National security, Brown believed, should be seen as providing the best possible environment for human life. In line with this, the early publications featured essays on deforestation (firewood crisis), population expansion, food production in North America, nuclear power, family planning, soil abuse, women in politics, and equal education for women. Brown was convinced that women had to have a more prominent role in policy making if environmental goals were to be realized.

Brown was known to be an indefatigable worker whose intensity, often likened to that displayed by Ralph Nader, sometimes confounded those in frequent contact with him. Nevertheless, the institute thrived under his leadership, and its publications (often in trans-



U.S. secretary of agriculture Orville Freeman (right) with New York City mayor Robert F. Wagner inspecting an architect's drawing of the Bronx's Hunts Point market in 1962. (Library of Congress)



Results of deforestation in the Amazon basin. (PhotoDisc)

lation) were distributed worldwide. Brown published prodigiously, with articles on population, declining cropland, automobiles, overfishing, and the food crisis in Africa appearing under his name. He published in diverse journals from *The Humanist* to the *Farm Journal*. While his articles continued to appear in dizzying numbers, he also wrote books based on research and analysis carried out by Worldwatch.

One of the most successful of these books, *The Twenty-ninth Day: Accommodating Human Needs and Numbers to the Earth's Resources*, was published in 1978. In this book, which was carefully vetted by his institute colleagues, Brown wrote about the ecological and economic stresses that were threatening the world's grasslands and ecosystems. He echoed the sentiments expressed by William Vogt in his *Road to Survival* (1948). Brown also appealed to people to understand the danger posed by excessive population and unbridled materialism. He specifically praised the work of Rachel Carson, Ralph Nader, and E. F. Schumacher. Schumacher's book, *Small Is Beautiful* (1973), demanded a reevaluation of the world's fascination with ever greater technology. Brown believed that global change began with individuals such as Schumacher and then expanded to include larger groups.

Brown's enthusiasm and drive enabled Worldwatch to continue its success in gaining financial support from U.S. and international agencies as well as from private foundations. The institute became one of the best-supported environmental organizations in the world. This financial backing, principally from the Rockefellers, enabled Worldwatch to begin its annual *State of the World* publication in 1984. Its purpose was to report on world progress toward the goal of a sustainable society. Brown believed that this would become the institute's most important contribution. Many Worldwatch associates contributed chapters to the book. There were reports on such issues as global warming, clean air, saving water, feeding the world, and ending poverty. The issues covered were different every year. The *State of the World* series provided Worldwatch with enormous visibility, and the books sold exceedingly well, particularly among high schools and colleges.

Brown continued his frenetic pace of issuing reports and calling attention to new areas of environmental concern into the 1990's. He succeeded in making the Worldwatch Institute the most widely known source of information in the United States about where human beings were heading in the continuing effort to find accommodation with their natural resources. Brown continued his prolific writings, serving as president of the institute until September, 2000, when he was succeeded by Christopher Flavin. In May, 2001, Brown went on to found a new organization known as the Earth Policy Institute, where he continued to publish widely.

SIGNIFICANCE

During the 1970's, hundreds of environmental groups and agencies formed around the globe. Their creation signaled the awakening of a significant portion of the world's population to the reality that natural resources were disappearing at an alarming rate. The groundwork for this awakening was laid during the 1960's and early 1970's, when ecologists and a few politicians began to point out that Earth is a small planet on which materialism, technology, and population growth had created a clear and present danger to the human environment. The 1972 U.N. Conference on the Human Environment in Stockholm, Sweden, declared that the preservation of natural resources was a global concern. Human actions in one part of the world

affected the environment of those living in another part of the world. After the Stockholm Conference, and with the end of the war in Vietnam, the popular cause became the conservation of essential resources through the limiting of pollution and the rethinking of personal and national goals. The Worldwatch Institute was founded in the midst of this rush to save the planet from human destruction. It was not the first such organization, but it was one of the earliest in the United States and one of the most enduring.

The impact of Worldwatch must be assessed in terms of the plethora of similar organizations forming at the time. There were several distinct advantages for Worldwatch. Its founder and president, Lester Brown, was relentless in his determination that Worldwatch should make a difference. His vast knowledge of agriculture and the world's food needs, combined with his liberal political philosophy and writing skills, made him a formidable force. He surrounded himself with talented people of similar convictions who were able to challenge his thinking and keep him renewed. Although Brown's leadership was the primary advantage that Worldwatch possessed, there were other factors that were nearly as important.

The institute's location in Washington, D.C., gave the group access to politicians and policy makers. Its publications were quickly disseminated to key individuals on Capitol Hill. Washington also had a pool of experts in all areas of interest to Brown, and vast library resources and the latest government statistics were within easy reach for Worldwatch's personnel. The Washington venue greatly facilitated fund-raising, which was another strong advantage for Worldwatch in comparison to other environmental groups. The money available made it possible to publish regularly, and eventually the publications themselves began to produce substantial revenue for the institute.

The impact of the Worldwatch Institute must be viewed from two perspectives: To what extent did the institute directly influence policy decisions and legislation, and to what extent did it indirectly influence the environmental movement through its broadcasting of information? Where policy and legislation are concerned, Worldwatch's influence is not easily differentiated from the efforts of other environmental agencies. It was a strong lobbying force for legislation and policy relating to clean water, emission standards for pollutants released into the air (particularly automobile emissions), and in mat-

A MESSAGE FROM THE WORLDWATCH INSTITUTE

On its Web site, the Worldwatch Institute describes its work as follows:

The Worldwatch Institute offers a unique blend of interdisciplinary research, global focus, and accessible writing that has made it a leading source of information on the interactions among key environmental, social, and economic trends. Our work revolves around the transition to an environmentally sustainable and socially just society—and how to achieve it.

The credibility and accessibility of Worldwatch research has made our publications popular among a cross-section of society, from government and business decisionmakers to the media, students, and the general public. Since the first Worldwatch Paper was published in 1975, the Institute has broadened discussion of environmental and social issues by analyzing them from a global and interdisciplinary perspective. This has produced fresh angles on the issues of the day, whether they are in the headlines or not.

ters dealing with food production. However, it is difficult, if not impossible, to cite a specific policy or law that resulted directly from positions taken by Worldwatch.

It was the indirect influence of Worldwatch that provided its greatest impact. By making information and statistical analysis readily available to policy makers, Brown believed that informed decisions would be made when these policy makers were confronted with choices that would affect the environment. This is one reason the institute's approach was so eclectic. Brown saw that, by the early 1980's, the U.S. Council on Environmental Quality (created by President Richard M. Nixon in 1969) had lost its momentum and Worldwatch had to fill the void. The issuing of the *State of the World* reports beginning in 1984 was Worldwatch's effort to draw together pertinent information from around the globe and integrate that information in a way that would prove useful to government officials, legislators, and the general public. Brown wanted to provide a basis for reordering priorities and also wanted to suggest different ways of evaluating the relationship between humans and their environment.

Although the *State of the World* reports were often criticized for lacking focus and being amorphous, they were immensely popular

and frequently cited in publications from the United Nations Environment Program. The hope of Brown and his Worldwatch colleagues was that through a broad interdisciplinary discussion of environmental issues, they would be able to reach people who had remained untouched by such matters. In this effort, the institute achieved considerable success. *The State of the World* reports, however, documented little progress in achieving sustainable societies.

Ronald K. Huch

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_____. *World Without Borders*. New York: Vintage Books, 1973. Presents Brown's global perspective on the human environment and provides an overview of the many ecological and economic problems that humans faced during the early 1970's. He suggests that a global economy and a global infrastructure will eventually reshape the future in a way that leads to sustainable societies. Notes, index, bibliography. Recommended.

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SEE ALSO: October 21, 1972: U.S. Congress Expands Pesticide Regulations; 1977: Berry's *The Unsettling of America* Examines Agricultural Ethics; 1985-1987: Burger King Boycott Called to Protect Rain Forests.

■ OCTOBER 23, 1974

U.S. CONGRESS CREATES COMMODITY FUTURES TRADING COMMISSION

Through creation of the Commodity Futures Trading Commission as an independent agency with the mandate to regulate futures markets in such commodities as meat products and agricultural produce. Congress sought to ensure the economic usefulness of futures markets.

ALSO KNOWN AS: Commodity Futures Trading Commission Act of 1974

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Government policy and regulation; Marketing and trade; Price supports and controls

KEY FIGURES

William R. Poage (1899-1987), U.S. congressman from Texas, chair of the House Agriculture Committee, and a strong proponent of the Commodity Futures Trading Commission Act

Herman E. Talmadge (1913-2002), U.S. senator from Georgia, chair of the Senate Agriculture and Forestry Committee, and strong supporter of the act

William T. Bagley (b. 1928), first chairman of the Commodity Futures Trading Commission, 1974-1978

George E. Brown (1920-1999), U.S. congressman from California, member of the House Agriculture Committee, and strong supporter of the act

Carl T. Curtis (1905-2000), U.S. senator from Nebraska and member of the Senate Agriculture and Forestry Committee

SUMMARY OF EVENT

The Commodity Futures Trading Commission Act of 1974 made comprehensive changes in the Commodity Exchange Act of 1936. The 1974 act created the independent Commodity Futures Trading Commission (CFTC), which was charged with regulating how farm and other commodities are traded on exchanges. The CFTC was en-

trusted with strengthening regulation of the commodity futures trading industry in the United States to ensure fair practices and honest dealings in futures exchanges. It was empowered to regulate and control all activities on the exchanges.

Formal commodity markets developed in the United States during the late eighteenth century. After keeping enough of a crop for his or her own needs, a farmer brought grain and livestock to the local market. Because of the rhythms of nature, most farmers brought their products to market at about the same time. Supplies of meat and grains generally exceeded the current demand of meatpackers and millers, causing the prices of commodities to slump. The price problem was further worsened by inadequate storage facilities and lack of standards for quality.

Several months after the harvest, the supply of commodities would shrink. With no stored commodities to draw from, prices would skyrocket, and people would often go hungry. Millers and meatpackers also faced problems when they lacked the raw materials necessary to run their operations. Closures and bankruptcies would result. The minimal proceeds that farmers received for their produce at harvest time were inadequate for the construction and development of storage and farming assets.

Transportation and storage facilities improved in response to the inadequacy of local markets in meeting the needs of suppliers and buyers of commodities. Forward contracting between farmers and merchants developed to offset, at least partially, the fundamental problem of demand and availability of the commodities. Forward contracting involved an agreement for the delivery of a commodity at a predetermined future date. All the terms and conditions of the contract regarding the price, quality, quantity, and packaging of the commodity and the place and mode of delivery were predetermined. Forward markets did little to control the risk arising out of crop failures, losses in transit, and bankruptcies in a volatile price environment. Moreover, lack of regulation resulted in lack of a reliable mechanism to ensure performance by the parties to a contract.

There were two major shortcomings of forward trading: a lack of secondary markets for forward contracts to enable the participants to "bail out" of a contract if they so desired, and a lack of a performance guarantee. These problems were eliminated as a system of futures

trading developed in the United States. The development of futures markets accelerated with increasing needs for large-scale risk transfer and centralized pricing in the agriculture forward markets.

In 1848, the Chicago Board of Trade (CBOT) was formed by eighty-two merchants. While Chicago became the primary location for the distribution and export of grains, New York developed into a similar center for cotton. These centers promoted competition and attracted traders from all over the world. Participants soon developed uniform systems for trading in these centers.

Futures trading on the CBOT began in 1865. Trading in futures, or contracts to deliver a commodity at a future date, required market participants to make and rely on forecasts of supply and demand. Prices that emerged for futures contracts reflected a consensus of those forecasts. High futures prices, for example, indicated a consensus that demand would be relatively high or supply would be relatively low.

Futures trading allowed hedging of price risks. A seller or buyer could lock in a price through a futures contract rather than take the risk of the price changing unfavorably before the delivery date. This reduction of risk allowed commodity handlers to operate at lower costs.

Rules and procedures for trading, clearing, and settling contracts were adopted during the late nineteenth century. Standardization of contracts and delivery dates also took place. Increased efficiency of commodity trading, however, rarely resulted in increased prices for farmers. Abuses in the commodity markets were frequent. These abuses arose from the very structure of the commodity markets. A speculator could enter into a large futures contract with a relatively small commitment of funds, since payment was promised in the future. The markets were dominated by large traders and speculators who exercised their economic power and manipulated markets to their advantage. Farmers had little faith in these markets but little choice about where to sell their produce. This lack of faith of farmers led to a revolt against the futures markets, and in 1893 the U.S. Congress came close to imposing prohibitive taxes on futures trading. During the first years of the twentieth century, the revolt against futures trading softened as a result of price increases for farm products and development of cooperative farm marketing. Pressure still was

building for federal regulation to ensure more stable and reliable futures prices and markets.

With passage of the Cotton Futures Trading Act of 1914, Congress attempted to regulate a farm product market for the first time. The end of World War I saw declining farm prices and increased demands for the regulation of futures trading. By passing the Grain Futures Act of 1922, Congress extended its regulation of futures trading. The Grain Futures Act empowered the secretary of agriculture to regulate the activities of a futures exchange but not those of the futures traders. Under the act, it was the responsibility of an exchange to prevent price manipulation on the exchange. Although the act provided for legal action against price manipulators, it proved inadequate in dealing with market abuses.

The ineffectiveness of the Grain Futures Act resulted in the passage of the Commodity Exchange Act of 1936, which extended the regulatory net to other commodities and made price manipulation a criminal offense. Broader powers were granted to deal with abuses and to prosecute any offending trader. The act was also designed to curb excessive speculation and to bring commodity brokerage under regulation.

Several minor changes were made to the Commodity Exchange Act between 1936 and 1967. In 1968, Congress set minimum financial standards for commission traders and increased the penalties for certain violations such as price manipulation. Until the early 1970's, the government's stockpiles of commodities played an important role in stabilizing prices. The government would buy farm products in times of declining prices and high output, then serve as a supplier in periods of low farm output. As the shift to a market-oriented economy free of government interference gained strength, government reduced its role in the commodities markets, and merchants increased their reliance on futures markets to protect themselves against substantial price changes.

Although many futures markets had been regulated to varying degrees since 1914, several important markets, including metals, coffee, cocoa, and sugar, were still completely unregulated by the federal government. The volume of trading on the futures markets was rapidly increasing, by 1973 reaching \$500 billion annually, much greater than the volume of financial securities trading on exchanges.

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It was apparent that futures markets had far-reaching effects on consumers, affecting them from their grocery bills to their housing costs. It also became apparent that commodities markets were just as important as securities markets for the country's economic development, resulting in demands for a single regulatory authority that would oversee and regulate the activities of all commodities markets. On October 23, 1974, Congress passed the Commodity Futures Trading Commission Act, thereby creating the CFTC. On April 21, 1975, the CFTC assumed all regulatory powers and functions pertaining to futures trading.

SIGNIFICANCE

The CFTC's task of overseeing and regulating a rapidly expanding and growing futures market was enormous. The commission was charged with regulating "any item of goods or services traded on a futures basis." Within a week of assuming regulatory responsibility, the CFTC proposed rules to prevent fraud in commodities options and gold and silver futures contracts. By July 18, 1975, the CFTC had expanded its scope of regulation from thirty-eight futures markets for farm products to eighty-two markets for all types of futures trading. Later in the same year, the CFTC approved trading on the first two financial futures, one for Government National Mortgage Association (GNMA) mortgage certificates and the other for ninety-day U.S. Treasury bills.

During the first nine months of its operations, the CFTC rejected a request by Jack W. Savage, who previously had been convicted of mail fraud, for registration as a commodity trading adviser. The commission also filed its first injunction proceedings against City Commodities, Inc., of Minnesota for fraud and other violations of futures laws.

During its first year, the CFTC put in place procedures for reparations, handling confidential data, and receiving reports required of foreign traders. It also enlarged its reporting requirements to new commodities. In 1976, the CFTC's enforcement division launched two hundred fraud investigations. In 1977, the CFTC proposed regulating options markets and suggested rules for consumer protection. During this early period, the CFTC handled several major crises, including a rise of coffee futures from \$0.55 per pound to \$1.50 in re-

sponse to floods in Colombia and frost damage to the coffee crop in Brazil. The CFTC also charged the Hunt family of Dallas, Texas, with taking futures positions in soybeans that far exceeded the speculative limits. The U.S. district court in Chicago found the Hunt family in violation of rules and imposed a civil penalty of \$500,000. It also prohibited family members from trading soybean futures for two years.

In 1977, the CFTC declared that it was legal for floor traders to engage in dual trade—for themselves and for customers—as long as the customers' orders were executed first. Trading firms were responsible for appropriate supervision of their employees.

On November 2, 1978, William T. Bagley retired as the first chairman of the CFTC. In his letter of resignation to President Jimmy Carter, he noted that the CFTC, after some initial start-up problems, had emerged as an efficient operating agency with a uniform set of trading rules and procedures.

The CFTC later designated several new contracts and contract markets including the Amex Commodities Exchange, Inc., for futures on GNMA certificates, the New York Futures Exchange for financial instruments and foreign currencies, and the Chicago Board of Trade for options on Treasury bond futures. Introduction of stock index futures contracts provided an effective means of hedging the overall direction of the stock market. By the end of 1982, stock index futures were trading on several exchanges.

During the last week of December, 1979, the Soviet Union invaded Afghanistan. On January 4, 1980, President Carter imposed an embargo on previously contracted wheat exports to the Soviet Union. In view of this embargo and the prospects of an abundant crop, commodity prices were expected to plummet. Traders and experts were concerned that this sudden shock, coupled with uncertainty about the price support program of the U.S. Department of Agriculture, would result in chaos in the marketplace. Large price declines were expected to result in margin calls in excess of \$400 million. The CFTC, after wide-ranging consultations, called for a two-day suspension of the trading of wheat, corn, oats, soybeans, soybean meal, and soybean oil. The two-day suspension gave the markets time to consider market conditions more carefully, and an almost certain market crisis was averted. The CFTC has since effectively intervened several

times to avoid or reduce crisis in several commodities, including silver and crude oil futures.

Standardized futures contracts in which quantity, quality, and location are established help meet specific requirements of buyers and sellers. Price is the only variable, and it is discovered through auction trading on the floor of an exchange. Farmers, merchants, and investors use futures contracts to protect themselves against fluctuating cash prices. Availability of nontraditional contracts such as futures on stock indexes, government bonds, foreign currencies, and other financial instruments provide means of hedging for all investors. Speculators, who generally have no trade interest in the underlying instrument or commodity, assume the risk the hedgers are attempting to avoid. Futures exchanges play the crucial role of clearing and settling contracts in these risk-transfer activities.

Rajiv Kabra

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U.S. Congress Creates Commodity Futures Trading Commission

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SEE ALSO: June 15, 1929: Agricultural Marketing Act Becomes U.S. Law; July 10, 1954: Food for Peace Program Sends Agricultural Surplus Abroad; January 11, 1983: U.S. Government Pays Farmers Not to Plant Crops.

■ NOVEMBER 16, 1974

UNITED NATIONS ISSUES DECLARATION ON HUNGER AND MALNUTRITION

The U.N. declaration recognized that a grave food crisis afflicted two-thirds of the world's population and acutely imperiled the basic human right to life and dignity.

ALSO KNOWN AS: Universal Declaration on the Eradication of Hunger and Malnutrition

LOCALE: Rome, Italy

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Famine and hunger; International food relief; Migration

KEY FIGURES

Sayed Ahmed Marei (b. 1913), Egyptian politician, secretary-general of the 1974 U.N. World Food Conference, and president of the World Food Council, 1975-1977

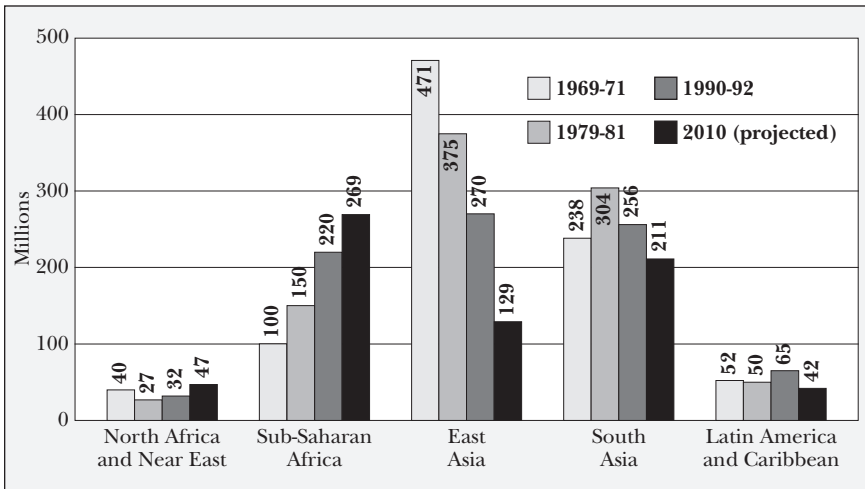
Giuseppe Medici (1907-2000), Italian agricultural economist and politician who served as president of the 1974 World Food Conference

Kurt Waldheim (1918-2007), president of Austria, 1986-1992, and secretary-general of the United Nations, 1972-1981

SUMMARY OF EVENT

The world food problem, including the history and geography of hunger and malnutrition, is a complex issue. Ever since Thomas Robert Malthus proposed his now-famous thesis that population growth increases exponentially while food production increases arithmetically and thus that food supplies will always be just barely adequate for a given population, the population-food imbalance has been a central issue surrounding the persistence of hunger. Other important factors include food production, foreign aid, national security, the international debt crisis, political power and oppression, land reform, the role of women in developing nations, literacy and education, employment, sanitation and health care, and environmental degradation.

NUMBER OF PERSONS CHRONICALLY UNDERNOURISHED IN DEVELOPING COUNTRIES, BY REGION



Source: United Nations Food and Agriculture Organization (FAOSTAT Database, 2000).

While statistics on the persistence of starvation prior to World War II lack accuracy, it is known that massive famines afflicted the Romans in 436 B.C.E. and India in 1291 C.E. An estimated 1.5 million of Ireland's 8 million people starved to death in the summer of 1846 during the potato blight. During the Soviet famine of the early 1930's, an estimated 3 to 10 million people starved as a result of the large-scale social dislocation resulting from Joseph Stalin's farm collectivization period. Flooding in West Bengal, India, in 1943 led to the loss of some 2 to 4 million lives through starvation. At the end of World War II, large numbers of people were close to starvation in Europe, particularly in the Netherlands. Mao Zedong's Great Leap Forward policy caused massive famine and social dislocation in China in 1958. Mass famines resulting from regional civil wars in Nigeria (1969-1970), Pakistan (1972), and West Africa and Ethiopia (1974) led to starvation for hundreds of thousands.

During the post-World War II years, food supplies in most developing countries moved upward at modest rates, but the shift was from a substandard diet for many human beings. During the early 1970's, however, the world witnessed a dramatic change in the international

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food situation that negatively influenced world hunger. The shift was related to a host of factors, including a soaring demand for food spurred by both global population growth and rising affluence.

The limitations of the international community's ability to respond to changing global food emergencies became clear by the late 1960's and early 1970's. World food reserves had gone from oversupply after World War II to a ninety-five-day supply in 1961, and then to a twenty-six-day global supply of grain by 1974. From 1962 to 1972, the world price of a bushel of wheat and that of a barrel of oil were roughly the same. Between the years 1973 and 1975, the price-setting policy of the Organization of Petroleum Exporting Countries (OPEC) essentially quadrupled world oil prices. As a result of OPEC oil price increases, among other factors, the price of wheat on the agricultural commodities markets soared, and breadbasket nations such as the United States had to pay for their rapidly rising oil-import costs with food exports. The very structure of the world food economy underwent a dramatic shift resulting in land, water, energy, and fertilizer shortages that had been unknown in earlier decades.

The Economic and Social Council (ECOSOC) of the United Nations in its 1973 sessions noted with concern the seriousness of this conspicuous shift in world food prices, availability, and distribution. On December 17, 1973, the General Assembly of the United Nations decided to convene the World Food Conference, to be held November 5-16, 1974, in Rome, Italy. The conference would study the problems of hunger and malnutrition facing the majority of the world's peoples. The conference was opened by Kurt Waldheim, secretary-general of the United Nations, and was attended by representatives from 133 states and six national liberation movements and by observers from twenty-six intergovernmental organizations. Those present examined new ways and means of increasing global food production and distribution.

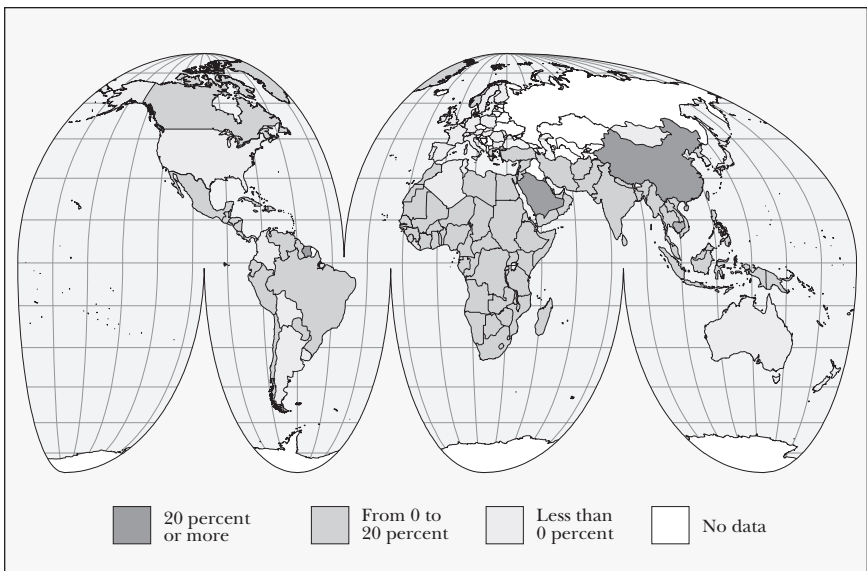
Waldheim noted with dismay that governments and the international community had failed to meet the target of a 4 percent annual increase in global agricultural production that had been called for four years earlier by the International Development Strategy for the Second United Nations Development Decade. Because excessive food imports and consequent drains on the foreign-exchange reserves of the developing countries had continued unabated, the con-

ference agenda included concrete strategies for increasing food production in both developing and developed countries, measures to strengthen world food security policy, and proposals toward stabilizing and expanding markets for exports from the developing nations.

On November 16, 1974, conference representatives adopted the Universal Declaration on the Eradication of Hunger and Malnutrition. The declaration's preamble and twelve principles were linked to the aims and objectives of the New International Economic Order (NIEO) that was set forth on May 1, 1974, by the U.N. General Assembly and designed to redress the international economic imbalance felt by the developing nations. The twelve principles of the declaration built on the principle that every man, woman, and child has an "inalienable right" to be free from hunger and malnutrition. The declaration called on governments to work cooperatively for equitable and efficient food distribution and adequate nutrition policies.

The declaration noted that states have the responsibility for removing obstacles to food production by means of agrarian, tax, credit, and investment policy reform, and for recognizing the key

INCREASES IN LAND USED FOR AGRICULTURE BY COUNTRY, 1980-1994



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role played by women in agricultural production. Appropriate education, extension programs, and financial facilities are to be made available to women as well as men. Marine and inland water sources are to be exploited for food requirements, even as food production at all levels is to be carried out with waste prevention policies in place and a willingness to conserve the planet's natural resources.

The declaration also specified that developed nations must aid developing nations by means of unconditional technical and financial assistance. The delicate interrelationship between the world food problem and international trade requires the cooperation of all countries in an effort to stabilize world markets and promote equitable and remunerative prices through international agreements. Finally, it is the common responsibility of the entire international community to secure adequate world food supply reserves, including emergency reserves.

SIGNIFICANCE

The most significant impact on human rights at the World Food Conference was the establishment of the World Food Council (WFC) on December 17, 1974. The WFC was the highest political body in the United Nations dealing with global food policy. It reviewed food pol-



Ship being loaded with grain for overseas food relief. (PhotoDisc)

icy proposals advanced by national governments and regional institutions and established cooperative, long-term global food policy. The WFC was suspended in 1993, and its responsibilities were taken over by the U.N. Department for Policy Coordination and Sustainable Development (DPCSD).

One important human rights development at the grassroots level was the establishment of World Food Day, observed each year on October 16. The day serves as an annual reminder of the scope and consequences of hunger and its principal cause, poverty. On many college and university campuses in the United States, students participate in a simple, symbolic meal of rice and water as an act of solidarity with the undernourished. Primary and secondary schools have held essay contests, workshops, debates, exhibitions, and farm visits as reminders of the basic human right to food.

WFC initiatives positively influenced global human rights. WFC policies raised the political profile and priority of world food issues, doubled the assistance of donor countries for food and agricultural development between 1975 and 1979, facilitated an agreement on a 7.6-million-ton Food Aid Convention, helped establish both an International Emergency Food Reserve administered by the World Food Programme (WFP) and a food credit facility in the International Monetary Fund, and continued to promote cooperation among less developed countries in food and agriculture.

Malnutrition continues to deny about 850 million human beings their basic human right to realize their full potential and human dignity. Every year, about 6.5 million children under the age of five die as a result of hunger and starvation. Suffering from undernutrition is concretely apparent in the young mother nursing her emaciated child during famine in Ethiopia, in the huddled masses of drought victims waiting to be admitted to a refugee camp in the Sahelian region of Africa, in the naked frames of Bangladeshi children living in shantytowns with inconceivably poor water and sanitary facilities, and in the dehumanizing barrios in Recife, Brazil.

Since the advent of the Universal Declaration, the overall percentage of people suffering from chronic undernutrition has declined. Although the 1974 Universal Declaration helped bring direct or indirect food aid relief to many victims of hunger, much more care and work remains to be done at the global level.

Political, economic, population, and environmental factors all thwart efforts toward the global eradication of hunger and malnutrition. In 1974, the United States opposed expansion of the WFP, which sought to aid in famine areas and to help vulnerable groups such as pregnant women and others through food-for-work projects. In late 1975, the U.S. Congress passed a new assistance bill, H.R. 9005, which many humanitarians hailed as an opportunity to recapture food aid for a human rights commitment. The bill, however, spelled out in no uncertain terms the link between U.S. food aid and the goal of expanding commercial markets for American commodities abroad.

When the representatives of many nations gathered at the Millennium Summit in New York City in 2000, gains were observed in the reduction of world poverty and in the number of people at risk of hunger. The number of hungry nonetheless still neared a billion, or about a sixth of the world's population, indicating that more work still remained to be done. One of the Millennium Development Goals that came out of the summit was to reduce by half the proportion of people around the world who are subject to hunger by 2015. The highest incidence of hunger remains in Africa, which has one-third of the world's hungry people, even as gains against hunger have been observed in Latin America, China, and other parts of Asia.

Gregory J. Walters

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SEE ALSO: May 18-June 3, 1943: United Nations Hosts First Conference on Food and Agriculture; February, 1962: United Nations Establishes World Food Programme; December 10, 1970: Borlaug Receives Nobel Prize for Work on World Hunger.

■ SEPTEMBER, 1976

LAND INSTITUTE IS FOUNDED TO DEVELOP ALTERNATIVE GRAINS

Wes and Dana Jackson founded the Land Institute for the development of perennial polyculture alternatives to annual grains, the harvest of which had caused severe erosion. The institute's goal would continue to be the creation of a sustainable agricultural system that would produce high grain yields.

LOCALE: Salina, Kansas

AGRICULTURAL ISSUES: Agrarian reform; Botany; Ecology and environment; Fertilizers; Genetic engineering; New crops and food products; Pests and pesticides; Scientific research

KEY FIGURES

Wes Jackson (b. 1936), plant geneticist, author, and cofounder and codirector of the Land Institute

Dana Jackson (fl. late twentieth century), cofounder and codirector of the Land Institute

Robert Rodale (1930-1990), founder of Rodale Press and an influential critic of conventional U.S. agriculture who promoted organic gardening

Wendell Berry (b. 1934), tobacco farmer, author, and leading advocate of sustainable agriculture

Gary Paul Nabhan (b. 1952), ethnobotanist, author, and advocate of sustainable agriculture and of maintaining the genetic diversity of crop plants

SUMMARY OF EVENT

In September, 1976, Wes Jackson and Dana Jackson founded the Land Institute in Salina, Kansas, to research and develop perennial grains that could be harvested as food for humans and animals and could be grown mixed together as plants grow in a prairie. The Jacksons envisioned a time when perennial crops would take the place of the annual grain crops of wheat, corn, and rice, among others. According to the Jacksons, the method of harvesting annual

THE LAND INSTITUTE'S MISSION STATEMENT

The Land Institute has worked for over 20 years on the problem of agriculture. Our purpose is to develop an agricultural system with the ecological stability of the prairie and a grain yield comparable to that from annual crops. We have researched, published in refereed scientific journals, given hundreds of public presentations here and abroad, and hosted countless intellectuals and scientists. Our work is frequently cited, most recently in *Science* and *Nature*, the most prestigious scientific journals. We are now assembling a team of advisors which includes members of the National Academy of Sciences. These scientists understand our work and stand ready to endorse the feasibility of what we have come to call Natural Systems Agriculture.

Our strategy now is to collaborate with public institutions in order to direct more research in the direction of Natural Systems Agriculture. We are seeking funds to construct and operate a research center devoted to Natural Systems Agriculture and to underwrite scientists elsewhere who will engage with us in such research. We estimate the research cost to be \$5 million a year for 25 years, which is a small fraction of one percent of the nation's annual agricultural research investment.

Important questions have been answered and crucial principles explored to the point that we feel comfortable in saying that we have demonstrated the scientific feasibility of our proposal for a Natural Systems Agriculture. Because this work deals with basic biological questions and principles, the implications are applicable worldwide. If Natural Systems Agriculture were fully adopted, we could one day see the end of agricultural scientists from industrialized societies delivering agronomic methods and technologies from their fossil fuel-intensive infrastructures into developing countries and thereby saddling them with brittle economies.

grain crops in the United States had led to erosion that seriously diminished the soil. If perennials could be bred to be sufficiently productive, they could become the basis for a different, more sustainable system of agriculture.

Wes Jackson grew up during the Great Depression on a forty-acre farm near Topeka, in the Kansas River Valley. In 1971, after acquiring a master's degree in botany and a Ph.D. in plant genetics, he was granted a tenured teaching position at California State University in

Sacramento. In California, he and his wife, Dana, also a native of the Kansas prairie, were influenced by the growing environmental movement. After three years in Sacramento, they returned to Kansas, looking for a way to use their expertise to solve the environmental problems facing agriculture there.

In September, 1976, the Jacksons opened a school to explore those issues with a handful of students. They opened the school on a minimal budget in a building they built themselves. The institute also contained a greenhouse and 277 acres of prairie used for observation and research. The annual budget was drawn mostly from private foundations, which were supplemented by individual donations, tuition fees, Wes Jackson's speaking fees, and the sale of produce from a market tended by students. About one dozen students would cycle through the institute program every year.

Dana Jackson became the administrator for the institute, while Wes Jackson became its theorist. The latter's work on perennial grains evolved in response to the question he asked himself: How could the erosion that was stripping North America of its best soil be permanently stopped?

When harvesting major grain crops, farmers strip the crops from the soil because they are annuals, which only fruit once. Then the soil is bare to wind and water, which carry soil away until seed is planted and roots grow, holding the soil down again. Jackson estimated that soil was eroding 25 percent faster than in the days of the Dust Bowl, although changes in methods of estimation made comparison difficult. It was generally accepted, however, that one-third of the cropland topsoil that was present when the first Europeans arrived was gone. For every bushel of corn grown in Iowa, it has been estimated, two bushels of soil are lost. This style of agriculture, Jackson pointed out, is unsustainable at such a rate of soil loss.

Jackson was not the first to criticize the U.S. model of agriculture, nor was he the first to propose sustainable models as an alternative. In this he joined Robert Rodale, Wendell Berry, and Gary Paul Nabhan. Rodale founded Rodale Press, which publishes the magazine *Organic Gardening* as well as numerous books and pamphlets on the subject of agriculture. In 1977, Berry first published his influential *The Unsettling of America: Culture and Agriculture*, in which he critiqued the destructive effects of U.S. agriculture on rural ecology

and community. Nabhan, an ethnobotanist and author, has sought to find and preserve locally adapted seeds, often those developed over the centuries by indigenous people of the Americas, which are being marginalized or lost due to the encroachment of hybrids.

In his books *New Roots for Agriculture* (1980) and *Altars of Unhewn Stone: Science and the Earth* (1987), Wes Jackson joined these men in their critiques of mainstream agriculture. Jackson was concerned that agricultural chemicals had become the leading polluter of streams and groundwater and that groundwater was being mined to support irrigation, depleting aquifers and leaving accumulations of salt in crop and pasture lands. Irrigation, he pointed out, requires the use of fossil fuel, as does the manufacture of fertilizer and pesticides. By the time the average U.S. citizen eats a single calorie of food, 9.8 calories of fossil fuel have already been used in the production of the food. Genetic diversity has been narrowed as scientists have bred small numbers of higher-yield hybrids to replace locally adapted seeds. In addition, the new hybrids are more vulnerable to pests and diseases than the old, and thus are more dependent on pesticides. Jackson called this model of agriculture "extractive," based as it is on the mining of soil, water, and petroleum. Furthermore, he criticized agriculture for becoming a capital-intensive industry in which many farmers, particularly smaller ones, have gone into debt to stay afloat but have lost their farms anyway. This trend has led to the destruction of numerous agricultural communities across the United States.

SIGNIFICANCE

Although Jackson shared his critique of large-scale U.S. agriculture with Rodale, Berry, and others, he was the first to conceive of a way to reform agriculture at its biological roots by replacing annual monoculture with perennial polyculture. While most scientists interested in plant genetics work to improve annuals, Jackson and his students broke new ground in their work with perennial polycultures. Theirs was a long-term project, likely, by Jackson's estimation, to run one hundred years before the desired results can be achieved, but he believed the potential benefits would make the effort worthwhile.

Jackson used the prairies as his model for what he called an ecological agriculture. The prairie is a complex system of many plants co-existing. There, soil is built up by plant roots rather than lost through

erosion, and because the roots are dense, deep, and never stripped from the land, they help to retain water.

Typically, three families of plants are intermingled in the prairie: grasses, legumes (a family of plants able to take nitrogen from the air and fix it into the soil), and composites, to which daisies and sunflowers belong. Jackson wished to retain this mix in his fields of the future. He imagined seed mixes sown every twenty years and harvested in such a way that the plants remain to produce again.

Perennials have a different reproductive strategy than annuals: They save a significant proportion of their energy for their root systems rather than putting it into seed production. The most obvious challenge to Jackson's vision is the difficulty of breeding perennials with increased seed yields.

Other challenges include developing higher-yield perennials that animals and humans want to eat, as well as breeding plants with heads of grain that can resist shattering as they are harvested, as wild grains generally release their seed when knocked. Not least, the complexity of the prairie ecosystem must be better understood; for example, what interaction occurs in the soil between roots of particular crops and fungi?

Researchers at the Land Institute have made a number of discoveries. They have found a strain of the Illinois bundleflower, for example, that may be able to yield more than 3,000 pounds of seed per acre and an *alta fescue* that can produce 1,460 pounds of seed per acre, while Kansas winter wheat produces an average of 1,800 pounds of seed per acre. Particular mutations discovered by researchers at the institute and elsewhere may provide momentum in the process, as, for example, the discovery of a kind of grass that has four times as many seeds as usual in long, soft bracts rather than the usual tight hulls.

Jackson claimed that if the fertilizer and pesticides on which the current dominant crops depend were removed, those crops could not survive. Jackson countered skeptics of his work by pointing out that the productivity of select perennial grains was comparable to that of the high-yield annuals minus their inputs, or external treatments such as fertilizers.

Jackson's goal would continue to be the creation of an agriculture that would need fewer inputs. Energy would come primarily from the Sun, not from petroleum, and the demand for water would be re-

duced. Because fields would be in polyculture, pests and diseases would not affect all plants in the same way, and would not be as devastating as they are to a monoculture. Some prairie species function as repellents for certain insects, a quality Jackson and his cohorts sought in their breeding programs. Perennial polyculture could include in its ecosystem the insects, birds, animals, and even fish that have been eliminated by pollution and habitat destruction from the fields of conventional agriculture. The institute's primary goal of saving soil would be its first and most demonstrable benefit. Jackson estimated that if all the acreage in the United States planted with the most common crops were switched to mixed perennials, the soil saved annually would exceed 3 billion tons per year.

The perennial agriculture Jackson proposed would have a more limited impact on the immediate environment and those locations where petroleum is extracted and processed. As this agriculture would also be far less capital-intensive, the pressure to expand into



*Wheat field that has been
contoured to minimize erosion.
(©Jeanne Hatch/
Dreamstime.com)*

ever larger units would be reduced, allowing small farmers to reduce debt and stay on the farm. According to Jackson, the health of the whole community, human and nonhuman, would be improved.

Time is not the only obstacle to Jackson's work. Many experts believe that the usual methods for containing erosion, such as contour terracing and crop rotation, are sufficient, despite the quantities of soil still lost. In particular, Jackson would lament that the U.S. Department of Agriculture was not interested in undertaking the development of perennial polyculture. Such involvement could, he argued, speed the process along by decades.

During the early twenty-first century, the Land Institute remained a small institution at work on a large-scale scientific investigation that could have major implications for soil and agriculture in the United States and around the world. The study's harshest critics have expressed doubt that it will succeed. Others believe that Jackson's most enduring legacy may be that he stimulated scientists and agriculturalists to look to nature, rather than to industry, as a model for solving environmental and economic problems.

Maya Muir

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■ 1977

BERRY'S *THE UNSETTLING OF AMERICA* EXAMINES AGRICULTURAL ETHICS

Acclaimed poet and novelist Wendell Berry published a collection of essays on the natural and ethical relationship between North American culture and agriculture. The book helped to broaden the goals of environmental organizations that had become complacent with their successes.

LOCALE: United States

AGRICULTURAL ISSUES: Diet, nutrition, and cuisine; Ecology and environment

KEY FIGURES

Wendell Berry (b. 1934), teacher and writer of fiction, poetry, and essays, as well as a farmer in the Jeffersonian tradition

Earl Butz (1909-2008), U.S. secretary of agriculture, 1971-1976

Thomas Jefferson (1743-1826), president of the United States, 1801-1809

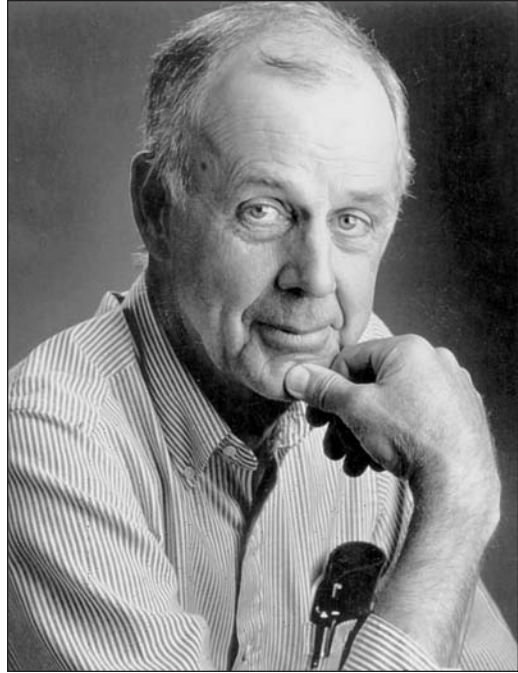
Albert Howard (1873-1947), British agriculturist

SUMMARY OF EVENT

Wendell Berry wrote *The Unsettling of America: Culture and Agriculture* (1977) as a result of a disagreement between Berry—a poet, novelist, teacher, and farmer—and the agricultural establishment in the United States, as epitomized by Secretary of Agriculture Earl Butz. When Butz and his administration departed Washington, Berry noted, their policies remained in place. Berry therefore concluded that the policies in favor of corporate agriculture were not temporary political maneuvers but rather long-standing structural concerns. Berry's argument against the agricultural practices advocated by the U.S. Department of Agriculture involves two separate but interwoven strands of analysis. The first concerns the cultural effects of agricultural modes of production—hence the book's subtitle. The second is the effect of agricultural practices on the environment, as well as the contributions of modern exploitative agriculture to the general decline of environmental quality.

*Wendell Berry's diverse writings
promote a sustainable agrarian
lifestyle in which human beings
coexist peacefully with nature.*

(Dan Carraco)



Berry's first argument begins not with Butz but with the history of the European colonization of the Americas, or what historian Howard Zinn calls the European invasion of the Americas. Chapter 1, "The Unsettling of America," offers the most extended commentary on the historical nature of the agricultural crisis. Berry finds a contradiction between two impulses embodied during the early settlers of North America. On one hand, the settlers fleeing persecution in Europe were looking for a place to settle and live—permanently. Against this noble ideal Berry finds a much stronger and insidious motivation among a significant minority: the drive to exploit the colonized land and the colonized people persistently and completely. Berry finds this pattern of exploitation to be carried through to the present day. After the colonists exploited the Native Americans, they in turn found themselves exploited by the European imperial governments, and so on into the 1960's, when, to Berry's shock and dismay, Butz and the Department of Agriculture established a policy of "get big or get out." Agriculture, once seen by Thomas Jefferson as the cornerstone of democracy, had become part of an aggressive foreign policy.

The modern agricultural mode of production, according to Berry, is an extension of the imperialistic mind-set of the early colonists. Berry continues his analysis of the superstructural effects of modern factory farming in two important chapters of the text: chapter 4, "The Agricultural Crisis as a Crisis of Culture," and chapter 8, "Jefferson, Morrill, and the Upper Crust." He begins chapter 4 in an anecdotal fashion, describing his boyhood in the farming region of Henry County, Kentucky. The productive and diversified farms of his boyhood are mostly gone, he writes, because of the false modernization of agriculture and the subsequent marginalization of the small farm. Berry places the blame on government emphasis on the technological fix, which turns the farmer away from self-reliance and self-employment and toward becoming simply another employee of the agribusiness concerns. The end result of this technological upheaval is a cultural tidal wave: As fewer farmers are required to produce food, the once independently minded farm dwellers become displaced, with most becoming consumers living a culturally disconnected life in the suburbs or the city.

Berry continues this line of argument in "Jefferson, Morrill, and the Upper Crust." Berry notes that Jefferson, the most philosophical of the Founding Fathers, always considered democracy to be joined to the issues of farming and education. For Jefferson, the small landowner was the ideal citizen of a democracy, living independently of any master but connected to the earth. Berry sees the decline of this ideal evident in the fate of the land-grant colleges established through the efforts of Justin Morrill and the Morrill Land Grant Act of 1862. Morrill discounted the idea of farming as a democratic institution, viewing it instead as a profession that needed only technical training. From this change in philosophy, Berry extrapolates to the mid twentieth-century, when public funds were diverted from small farms and public interest to factory farms and corporate interests.

Berry intersperses his analysis of the cultural crisis with his analysis of the ecological crisis. Two chapters emphasize different aspects of the ecological crisis: chapter 3, "The Ecological Crisis as a Crisis of Agriculture," and chapter 7, "The Body and the Earth." Chapter 3 lays the groundwork for Berry's ecological analysis. Berry's first point is that the traditional environmental organizations have overlooked

the question of land use in favor of preservation of wilderness or prevention of particularly abusive practices such as strip mining. Berry points out that the greatest amount of land used in the United States is used for agriculture and that environmental groups have been acting in an elitist fashion by ignoring rural issues. Although Berry is strongly in favor of wilderness conservation, he argues that most land will eventually have to be used. The basis of his conservation ethic is thus an argument for kindly and responsible use of all lands, particularly agricultural lands. Otherwise, he states, the quality of food will continue to decline, and waste will continue to be institutionalized. Berry's scientific source here is not Thomas Jefferson but British agrarian Albert Howard, author of *The Agricultural Testament* (1940). Howard, like Berry, argues that the health of the soil can be improved only through organic and kindly methods and that the health of the soil can even be linked to the health of the body.

Berry elaborates on the second argument in chapter 7, "The Body and the Earth," in which he puts a more philosophical gloss on the same issue. Moving beyond the obvious environmental damage created by poor agricultural practices, Berry views ecology in the broadest sense as the connection of the human body to the planet Earth. His argument rests on a correspondence between our treatment of our bodies and our treatment of Earth. Although he admits that many readers may find this correspondence a strange one, Berry carries his argument to its logical conclusion. If our relationship to Earth is one of exploitation and abuse, then our personal environments should exhibit the same symptoms of decline. Berry addresses, respectively, the issues of mental and physical health, competition, sexuality, and fertility. At this point Berry's analysis becomes exegesis, and he leaves the boundaries of the traditionally environmental for the realm of the religious.

SIGNIFICANCE

The Unsettling of America ranks with Aldo Leopold's *A Sand County Almanac*, and *Sketches Here and There* (1949) as an influential work on the environment that also ranks as a literary work of the first order. The book received positive reviews from trade publications, poets, novelists, and environmental organizations, some of which changed their

policies after reading Berry's cool-headed critique of the biases underlying the environmental movement. The work in many ways represents a synthesis of several previously independent movements within the environmental community, and it helped to broaden the goals of organizations that had become complacent with their successes.

Sections of *The Unsettling of America* were originally published in two very different journals, *The Nation* and *The CoEvolution Quarterly* (later known as *The Whole Earth Review*, a publication affiliated with *The Whole Earth Catalog*). *The Nation*, the longest-publishing weekly newsmagazine in the United States, represented a New York/East Coast version of traditional American radicalism. *The CoEvolution Quarterly*, published in Sausalito, California, represented a newer and brasher segment of the environmental and social movement, based in large measure on the politics of 1960's California. That Berry, a writer from the agrarian tradition of the American South that traces itself back to Jefferson, could connect these two groups illustrates the significance of his work. His insistence on democratic idealism, which forms one of the bases of the work, was a link that joined the three regions and seemingly different traditions.

Politically, Berry's book is one of the hallmarks of late 1970's environmentalism. Though the environmental movement as a whole suffered a number of defeats with the election of Ronald Reagan to the presidency in 1980, membership and involvement in environmental groups grew and continued to do so throughout most of the 1980's. Several of the authors cited in *The Unsettling of America* rose to political prominence during the 1980's. Barry Commoner, scientist and author of *The Closing Circle* (1971), was the founder and 1980 presidential candidate of the Citizen's Party, forerunner of and model for the worldwide Green political parties. Jim Hightower, a prominent figure in the Democratic Party, later became agriculture commissioner of Texas and implemented many of the policies suggested by Berry in an attempt to benefit the small farmer.

The book's greatest political contribution within the environmental movement itself came about as a result of its emphasis on the ethical nature of environmentalism. Berry states that environmentalism cannot be quantified into simple economic abstractions: It is instead based on ethics and character. Although *The Unsettling of America* was

first published by the Sierra Club, Berry had no qualms about revealing the information that the organization had only recently divested its holdings in Exxon, General Motors, Tenneco, strip-mining companies, and pulp mills. The divestment itself, as Berry notes, came about because of public embarrassment over the publicity concerning the holdings. While Berry lauds the organization for its quick action in divesting, he notes that such behavior is typical of the flaws in the modern mind and character. Berry may not have been the first or the only writer to stress socially responsible investing practices, but

BERRY'S PESSIMISTIC UPDATE

In the preface to the 1986 second edition of The Unsettling of America, Wendell Berry states that the agricultural crisis he discussed in the first edition had gotten worse by the mid-1980's.

When I was working on this book—from 1974 to 1977—the long agricultural decline that it deals with was momentarily disguised as a “boom.” The big farmers were getting bigger with the help of inflated land prices and borrowed money, and the foreign demand for American farm products was strong, so from the official point of view the situation looked good. The big were *supposed* to get bigger. Foreigners were *supposed* to be in need of our products. The official point of view, foreshortened as usual by statistics, superstitious theory, and wishful prediction, was utterly complacent. Then Secretary of Agriculture Earl L. Butz issued the most optimistic, the most widely obeyed, and the worst advice ever given to farmers: that they should plow “fencerow to fencerow.”

. . . And now, almost a decade later, it is evident to everyone that, at least for farmers and rural communities, the situation is catastrophic: Farmers are losing their farms, some are killing themselves, some in the madness of despair are killing other people, and rural economy and rural life are gravely stricken. . . .

. . . Our soil erosion rates are worse now than during the years of the Dust Bowl. In the arid lands of the West, we are overusing and wasting the supplies of water. Toxic pollution from agricultural chemicals is a growing problem. We are closer every day to the final destruction of private ownership not only of small family farms, but of small usable properties of all kinds. Every problem I dealt with in this book, in fact, has grown worse since the book was written.

the fervor with which he castigates those who place convenience above ethical behavior helped add momentum to what has become a significant social phenomenon.

Finally, perhaps the greatest impact that Berry's book has had comes from its insistence on the importance of "marginal agriculture," which is Berry's term for the organic farming movement. At the time of publication of the text, organic farms represented at best a marginal segment of the agricultural economy. Berry's analogy is both startling and accurate: He compares modern orthodox agriculture to orthodoxy in religion and concludes that agribusiness has become evangelistic in its zeal. Like religion, Berry argues, modern agriculture can be shaken only by a movement that begins at the margins. Berry finds organic farming, especially the type practiced by his favorite farmers, the Amish, to be the agricultural equivalent of the voice crying in the wilderness.

Not satisfied with the strictly moral argument, however, Berry also relies on scientific studies from anthropologists and scientists, in particular the work of Albert Howard and Barry Commoner. Howard, a British soil scientist, influenced British agricultural practices with his works published during the 1940's. Commoner provides a scientific rationale for organic soil management, and he argues conclusively that organic farms can produce crops as abundantly and much more efficiently, from the standpoint of energy consumption, than corporate farms. Berry disagrees with Commoner on the use of draft animals instead of tractors. Berry notes that the Amish are able to farm and prosper using only draft animals for power and have done so without the massive government subsidies given to corporate farms.

Berry concludes with a twelve-point plan of action designed to help protect the small organic farm, much of which is now in place in states with certified organic produce programs. Berry's ideas are not necessarily new ones. He admits to borrowing his ideas on government intervention from Thomas Jefferson, who argued that "the earth is given as common stock for man to labor and live on." Such a philosophy continues to inform the agricultural and cultural movement influenced by Berry's book.

Jeff Cupp

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■ 1980

MEDITERRANEAN NATIONS SIGN ANTIPOLLUTION PACT

Acting under the auspices of the United Nations, Mediterranean nations agreed to cooperate to curb pollution. Their agreement had important implications for agriculture throughout the Mediterranean basin, but questions remained about whether ecologically desirable approaches could assume priority status in widely diverse national political settings.

LOCALE: Geneva, Switzerland

AGRICULTURAL ISSUES: Ecology and environment; Fertilizers; Government policy and regulation

KEY FIGURES

Michel Batisse (1923-2004), president of the Blue Plan Regional Activity Center in Sophia-Antipolis (Cannes), France

Mostafa Kamal Tolba (b. 1922), executive director of the United Nations Environment Program, 1976-1992

Jacques Cousteau (1910-1997), marine biologist and explorer of underwater ecosystems

SUMMARY OF EVENT

When more than fifteen Mediterranean nations signed a Mediterranean pollution control agreement with United Nations Environment Program (UNEP) sponsorship in 1980, a new emphasis was given to serious pollution problems that had been identified years earlier. In 1975, UNEP allocated more than \$7 million to the Mediterranean Action Plan (MAP) to aid Mediterranean seacoast countries in their efforts to fight obvious pollution problems. U.N. money represented the lion's share of funds to be disbursed, since the total expected from Mediterranean participants in the 1975 MAP agreement amounted to only \$375,000. Within one year, still another agreement, known as the Barcelona Convention, was signed by the signatories to the MAP.

At least one other precursor to the 1980 antipollution pact dem-

MEDITERRANEAN NATIONS IN 1980



onstrated notable shortcomings in the original concept of international cooperation sparked by the 1975 MAP. Early in 1979, UNEP informed signatories to the 1975 agreement that it was planning to cut back future financial support from MAP because of limited funds and increasingly important commitments UNEP had undertaken elsewhere in the world. Specifically, the U.N. agency stated that it was “incompatible with UNEP’s catalytic role to envisage permanent financial support to individual programmes.”

The agency called a February, 1979, conference in Geneva, Switzerland, to prepare a new approach to budgetary demands for immediate environmental remedies, as well as to map out a strategy for protecting future ecological conditions throughout the Mediterranean basin. In Geneva, a two-year work program was drafted, identifying some twenty-three environmental protection projects demanding immediate attention. A budget of \$6.5 million was established, one-half to come from the seventeen participating Mediterranean countries, one-fourth from UNEP, and the remaining one-fourth in the form of contributions in services and staff time from twelve international organizations involved in environmental protection. At the outset, it was apparent that this budget would not go far, so only three less financially demanding projects were approved for immediate attention. Member states were apparently as concerned about where the MAP headquarters was to be established (Athens, Barcelona, and



Italian farm overlooking the Mediterranean Sea. (©Sabrina Dvihally/Dreamstime.com)

Monaco were all proposed) as they were about the type of work to be undertaken during the 1980's. A decision was postponed, however, until 1980, when the same countries would meet to take already existing antipollution accords to the next level.

SIGNIFICANCE

After 1980, much of the antipollution efforts originally conceived as falling under U.N. sponsorship had, in the Mediterranean area as well as in other areas, as much to do with sharing preventive comparative research findings as with spot projects to solve existing problems. In fact, the staffs of international researchers who formed what came to be called Blue Plan Regional Activity Centers received a mandate. They were to provide data to the political authorities of all MAP countries to help them plan future economic development in a way that would avoid the damages already done in the sea itself and along its coastline during the 1970's. Each of these centers, such as the Sophia-Antipolis research complex near Cannes, France, was to be included in the research budgets of separate national signatories to the MAP agreements of 1975 and 1980. The U.N. role was to facili-

tate communication among these centers and to sponsor international meetings to share findings and propose solutions on a regular basis.

Essential to the Blue Plan approach to Mediterranean ecology during the 1980's was the challenge of constructing several scenarios of what the entire area might look like in twenty years (by 2000) or forty-five years (by 2025). After a decade of research, these scenarios, which were far enough along to be presented in published form, rested as much on economic and demographic variables as on formal ecological data per se. While the Blue Plan studies did incorporate observations, many very critical, of existing environmental issues during the 1980's, the studies' larger objective was to save the MAP countries the much higher costs of greater and perhaps irreversible problems in the future.

Blue Plan researchers, who were comparing economic conditions of the 1980's with future scenarios, divided their concern into five areas: food production, industry, energy use, tourism, and transport. Some areas, such as food production (agriculture and livestock), were closely associated with issues of ecological impact. Measuring variables such as the surfaces of naturally fertile land, available water resources, and patterns of crop or livestock use could show comparative levels of productivity as well as gradual depletion of resources on a country-by-country basis.

Agricultural studies in all Mediterranean countries indicated, for example, that modernization—through the introduction of tractors or chemical fertilizers in countries such as Egypt—produced short-term gains that could be more costly in the long term. In this domain, countries such as Egypt, with alarming demographic statistics and unique conditions created by unpredicted side effects from the massive Aswān High Dam, could not be readily compared with more technologically developed countries on the European side of the Mediterranean. Blue Plan comparisons of food production potential between non-European countries were complicated by many factors beyond mere technology differences. Egypt, with a seemingly unlimited Nile River water supply, could not be considered in the same terms as, for example, Algeria, where water resources were scant but the promising potential for expanding petroleum production could affect future food production.

By contrast, a common variable that could help compare relationships between economic performance and ecological repercussions in all Mediterranean countries, whatever their level of technological advancement, was the relative size of agricultural units. Blue Plan studies traced, for example, the ecological costs (namely, erosion) of standard agricultural development procedures during the 1960's and 1970's, such as expanding farmland by using tractors to transform previously uncultivated surfaces. The studies weighed these ecological costs against the benefits of using alternative technologies, including carefully developed fertilizers and improved irrigation, for example, to intensify production on what had been the traditional farmlands of each country. Another area of agro-industrial recommendations that were generated by Blue Plan studies involved ecologically safe "soil-less" alternatives to traditional farming or animal husbandry. These alternatives included indoor gardening or crop production and increased use of enclosed animal-feeding pens to replace open grazing on ecologically fragile, arid land.

Studies showed a considerable need to recognize differences between recommendations to retain or change traditional land tenure or cultivation techniques—which varied considerably according to economic class—and realistic possibilities for legislation affecting social class relationships. The fact that data were offered without a specific framework requiring political conformity undermined the practical realization of the MAP recommendations. This fact held true not only in the agricultural sphere but also in all areas of presumed joint ecological concern. Ongoing patterns of agro-industry, energy consumption, and tourism in each country, for example, represent politically sensitive issues at national levels that remain beyond any sphere of authority defined in the original MAP or subsequent joint Mediterranean agreements.

Jointly sponsored research suggested that some geographically concentrated areas of ecologically harmful heavy industrial activity, such as mining and metallurgical processing, as well as petrochemical production, were overproducing for stagnated or artificially sustained local national markets. Ecologically preferable and economically logical adjustments in such cases could involve integration of regional suppliers and markets (for steel or coal, for example). While Blue Plan recommendations such as these were being published,

however, two prime examples of difficulties barring realization of intraregional production and consumption markets could be cited. First, Turkey, a major coal and steel producer, continued to be in fierce disagreement with its neighbor, Greece. Second, despite the logic of participating in a confirmed producer-consumer market, Tunisia and Algeria (the latter already a producer of natural gas and petroleum) saw only minor attractions for energy market cooperation with each other. Tunisia therefore continued throughout the 1980's to intensify, at great capital and ecological cost, its own limited petroleum production schedule.

While these are specific examples of neighboring countries neglecting joint production and consumption planning because of essentially political reasons (and thus suffering economic handicaps in the process), a related area of Blue Plan concern reflected broader reasons for alarm over the potential ecological costs of delaying energy policies that would link all Mediterranean countries. Reports of participating scientists from all the MAP countries agreed, for example, on the necessity of encouraging wider use of clean energy sources, beginning realistically with natural gas, and aiming eventually at high-technology nuclear or, ideally, solar energy production—a seemingly logical direction for Mediterranean sun-belt countries.

The question remained, however, whether ecologically desirable approaches could assume priority status in widely diverse national political settings. Diversity of commitment to clean energy-use programs would necessarily be even more marked in countries such as Greece, Turkey, Syria, Lebanon, and Egypt, where economic investment limitations would mean unequal potential for access to supply markets, either for clean energy products themselves or for the technology to develop effective alternatives to the continued use of heavy pollutants such as coal or cheap fuel oil. Thus Blue Plan researchers' Mediterranean scenarios in the spheres of industrial and energy production and consumption—such as the presumably more traditional, but no less complex sphere of agriculture and animal husbandry—could be seen by the end of the 1980's to fall far short of the realistic national, political, and economic capacities of individual countries who supported the ideal objectives of the MAP.

The question remained whether the same could be said of other areas of Blue Plan ecological planning logic in which transformation

of alarming trends noted during the 1970's would not necessarily demand higher levels of capital investment. Two examples drawn from Blue Plan findings suggest that national-level political as well as economic sensitivities can still hinder ecological planning. These concern the areas of population growth and the expanding tourist trade.

Population planning (or family planning) represents a sensitive area because it is often influenced by both socioeconomic and religious practices that are not easily affected by logical legislative preferences. In the case of expanding tourist trade, formidable difficulties exist for Blue Plan theorists who, when they tell representatives of countries as different as France and Egypt that excessive construction of tourist havens may endanger the ecological balance, do not keep in mind a basic economic fact: Some poorer Mediterranean countries have come to view tourism revenues as one of the main supports of their national budgets.

Considerations such as these caused Blue Plan reporters in 1989 to close their comprehensive technological studies with a correction of the original wording of United Nations-sponsored agreements in 1979 and 1980. Whereas the 1980's mandate implied that "the struggle for the environment will take place primarily at the national level," by 1989 the MAP supporters believed that the next step would have to be truly all-Mediterranean planning, with movement in stages toward, for example, an international convention on energy production and distribution in the Mediterranean, and even a single and binding program for distribution of tourism development—all ambitious hopes facing formidable political obstacles.

Byron D. Cannon

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■ JUNE, 1980

MODERN RADAR REVEALS EXTENT OF MAYAN IRRIGATION SYSTEMS

Radar images indicated the presence of a network of canals in areas surrounding Mayan population centers. With the development of aerial radar mapping, it became significantly easier for scientists to screen large, unexplored areas for the presence of human-made structures.

LOCALE: Belize; Guatemala

AGRICULTURAL ISSUES: Archaeological discoveries; Ecology and environment; Population growth; Subsistence agriculture; Tropical produce

KEY FIGURES

John Lloyd Stephens (1805-1852), American attorney, explorer, and minister to Central America who wrote extensively about his explorations of the Mayan ruins

Frederick Catherwood (1799-1854), English illustrator and explorer

Diego de Landa (1524-1579), Spanish Franciscan priest who was appointed bishop over the Yucatán

SUMMARY OF EVENT

Like the Aztec and Inca civilizations that had been discovered and documented in Central and South America by explorers Hernán Cortés and Francisco Fernández de Córdoba during the sixteenth century, the Maya were contacted as early as 1502. After the plundering of the Aztec capital Tenochtitlán, near present-day Mexico City, in 1521, the Spanish conquistadors turned their attention south. Cortés sent one of his captains, Pedro de Alvarado, with a small force of Spanish soldiers and a contingent of twenty thousand native troops, and shortly thereafter, Guatemala and San Salvador were under Spanish rule. In addition to the diseases that were introduced to the continent, the conquest also involved the destruction of the Indian identity. This reached its zenith on July 12, 1562, with the destruction of an entire Mayan library of pictographic books and codi-

ANCIENT MESOAMERICA



ces by Friar Diego de Landa. To date, only four of these volumes are known to remain.

Clashes between the Spanish and various indigenous tribes occurred throughout the entire Central American region and lasted almost twenty years. What was revealed to the Europeans was a vast landscape of empty cities. It was apparent that the conquered Mayan nation was a shadow of its former self.

In 1840, these empty ruins were brought to light again by the explorations of John Lloyd Stephens and Frederick Catherwood, who documented the remains of eight ruined cities. These cities included Quiriguá, Copan, Palenque, and Uxmal. The region was lightly populated, with large areas of rain forest being systematically cut down and burned to provide growing space and fertilizer for several years of farming. The practice, commonly called slash-and-burn farming, was being carried out by the indigenous population. This practice is characteristic of present-day subsistence-level farming in tropical rain forests.

This type of agriculture, however, could not have supported the estimated fourteen million people that had occupied those now dead cities. The Aztec in central Mexico used more advanced techniques to include *chinampas* (artificial islands) and irrigation, while in South America, the Inca practiced terracing and fertilization.

At that time, however, there was little evidence found in Central America of these advanced horticultural techniques. What Stephens and Catherwood did discover was a complex system of *cenotes* (reservoirs) as well as artificial *aguadas* (wells). Farmers used these wells, not knowing that they were constructed earlier. Dry-season excavations of the wells found evidence that they were human-made. A survey of one locale revealed more than forty such constructions. It was not known who built these structures and why they were abandoned.

Part of the mystery is that the Mayan civilization began its decline about 900 C.E., leaving behind its cities and petroglyphs. Several theories say that the culture declined either as a result of conquest by neighboring nations or as a result of famine causing the Maya to migrate and merge with one of the other cultures. Until the late 1970's, the prevailing thought was that a climatic change caused a drought, with the slash-and-burn type of farming unable to support a large population under those extreme conditions. It became apparent that the lack of any large-scale land surveys, combined with the limited fieldwork done on nonurbanized areas, would continue this debate over how a large Mayan population had supported itself.

From October, 1977, until August, 1980, the National Aeronautics and Space Administration (NASA) made available an airborne, side-looking radar to begin detailed mapping of northern Belize and northeastern Guatemala. The radar was designed originally for the radar mapping of the surface of the planet Venus, but a more suitable application appeared to be the mapping of the swamps and jungles that make up two-thirds of the Mayan territory. This would allow researchers to see through the tree cover and marshland and for the first time allowed a large region to be investigated for the presence of human-made structures. The focus of this mapping was on the site of Tikal, the largest site identified with Mayan culture.

The radar provided an image that varied from ten to twenty-one kilometers in width, with a resolution of twenty meters. Many of the large buildings cast shadows and the large, flat surfaces reflected the radar, showing up as spots of light. What surprised the researchers was the appearance of intricate patterns of lines in areas known to be swamps. Because these lines were confined to low-

lying land, the immediate label given to them was canals, as used for either transportation or drainage. If further examination proved this correct, then it meant that instead of subsistence-level agricultural practices, the Maya had developed a more sustainable form of farming.

The next step was confirmation of these data with on-site excavations. Ground examination indicated a system of raised fields with the canals acting as drainage conduits, therefore correlating with the information gathered by aerial imaging. In addition, an excavation found canals one meter wide separating fields that were three meters square. Because of the radar's resolution, however, these features remained for the field archaeologist to interpret. It was found that many of these fields were artificially raised to make them more suitable for agriculture. The Maya may have utilized these raised fields to grow a variety of food and fiber plants. Analysis of pollen and other plant debris indicates the presence of corn, cotton, and amaranth. Unfortunately, the presence of these plants can be explained by either human cultivation or the self-reproduction of wild species.



Although Guatemala's Tikal ruins are the largest Maya site in Mesoamerica, the dense trees growing in and around the site have long made the complex difficult to study. (©Vladimir Korostyshevskiy/Dreamstime.com)

Water lilies are also associated with these raised areas. Studies have shown that these plants provide a good mulch for the crops that could have been grown on these elevated islands.

The radar could not discriminate between ancient and modern structures, as such; railroads, highways, airstrips, and natural geologic structures were picked up also. Of additional interest, however, is what appears to be the presence of some paved areas, possibly roads built by the Maya.

SIGNIFICANCE

The radar land-mapping technique altered the way archaeology is viewed and added much to existing knowledge about the Mayan civilization. Traditionally, archaeology has been thought of as a science requiring laborious methods and extensive human resources to accomplish the work of literally uncovering past civilizations. With this new tool of aerial radar mapping, however, it became significantly easier for researchers to screen large unexplored areas for the presence of human-made structures. The past image of archaeology involving hundreds of laborers removing debris was replaced by the image of technicians poring over airborne images.

Knowledge of the Maya also changed. It was never fully understood why the Maya would build large cities in what appeared to be vast swamps. Because these lands, when drained, could provide a stable agricultural base, the Maya might have considered this land the most valuable. The extent of the network of canals indicates a high degree of centralization; an estimated 2,500 square kilometers (or 250,000 hectares) of land in Belize and the Peten region alone were subjected to this type of hydraulic engineering.

The work was not easily accomplished, as the indigenous culture did not have the wheel, any draft animals, or iron tools prior to the arrival of Western explorers. This means that all the work was done manually, with stone tools and baskets to move the debris. A research team tried to replicate the construction of a raised field using tools and techniques that the Maya would have employed. From this work, the team estimated that it would have taken a minimum of 500,000 laborers to build the fields in fifty years. Another possibility is that the system of canals may have evolved during the life span of this culture. Like all Mesoamerican cultures, the Mayan culture had

at its base the farmer. It is reasonable to assume that during the height of the society, as many as ten million people were working the land.

This revelation also helped scientists to reevaluate how the agricultural capabilities of the tropical rain forest are viewed. The practice of slash-and-burn farming bankrupts the fragile soil, whereas the use of silt and aquatic plants dredged from those canals can act to build the topsoil, add additional nutrients, and lead to more productive farming practices. Some observers have expressed hope that the people of Central America will take advantage of the new knowledge gained in the study of the Maya. By the early years of the twenty-first century, a shift appeared to be starting, with the training of native farmers in a more regenerative style of agriculture. This is likely to be the most lasting impact of the discovery and study of the canal systems of the Mayan civilization.

Charles A. Bartocci

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■ JUNE 16, 1980

U.S. SUPREME COURT RULES ON CALIFORNIA WATER RIGHTS

In its Bryant v. Yellen decision, the U.S. Supreme Court overturned rulings that would have restricted delivery of irrigation water to large landholders in California's Imperial Valley. The decision confirmed the status quo, but it did not address the issue of aridity in California's valleys.

ALSO KNOWN AS: *Bryant v. Yellen*, 447 U.S. 352

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Drought; Ecology and environment; Government policy and regulation; Irrigation and water management

KEY FIGURES

Byron White (1917-2002), associate justice of the United States, 1962-1993

John Wesley Powell (1834-1902), founder of the U.S. Geological Survey and an expert on aridity and irrigation

Elwood Mead (1858-1936), engineer and proponent of state water control

William Hammond Hall (1846-1934), early advocate of state water control

James Ben Ali Haggin (1827-1914), large landholder and defendant in a famous water rights case

Ben Yellen (1902-1994), advocate of small landholdings

SUMMARY OF EVENT

In 1991, California experienced its fifth consecutive dry year in a cycle of drought. Californians were then consuming 35 million acre-feet of water annually, and there was a deficiency of nine million acre-feet to be made up from reservoirs and other sources. (An acre-foot of water covers one acre to a depth of one foot.) Emergency restrictions were imposed on the state's cities. Southern California's Metropolitan Water District, which includes Los Angeles, cut its flow to consumers by more than 30 percent. Severe restrictions also affected the

THE CALIFORNIA WATER PLAN

Because of California's population growth, the U.S. Department of Interior has estimated that by the year 2020, California will have a water deficit of approximately 780 billion gallons (3 billion cubic meters). Southern California, which includes the cities of Los Angeles and San Diego, has a large population. Because this area does not receive a large amount of rain, it must find external water sources. A vast system of dams, aqueducts, tunnels, and canals has become the greatest water transfer system in the world. Water is brought to Southern California from as far away as 160 miles (250 km.) to the east, from the Colorado River, and from as far away as 500 miles (800 km.) to the north, from the Sacramento River. This large water use relative to the limited supply has prompted water-saving measures such as irrigation practices, low-flow showerheads, and more water-efficient industrial techniques.

heartland of the state's huge agribusinesses, the Central and Imperial valleys. The state's water project stopped delivering water to farmers, and the Central Valley project reduced its deliveries, mostly to farmers, by nearly two-thirds. Californians reported in some polls that the wastage of water ranked second, after crime, as their major concern. Clearly, water could no longer be treated as if it were free.

California, like most of the western United States, is naturally arid. Authors of nineteenth century textbooks guessed correctly when they described much of the vast trans-Mississippi region (even before it was explored in detail) as the "Great American Desert." Eastern and inherited European farming techniques and crops could not be transplanted there successfully.

As a result, from the 1870's to the early twentieth century, congressional, California, and territorial legislation grappled experimentally with the unfolding difficulties posed by the aridity of the West. Irrigation seemed an immediate answer, with the achievements of Utah's Mormon community setting the example. Aridity and irrigation both raised issues that John Wesley Powell, an explorer of the West and later director of the U.S. Geological Survey, sought to unravel in studies of the West and to explain in his prophecies about the limitations of irrigation. Powell's cautionary studies elicited positive responses in

California from William Hammond Hall, a California engineer and an advocate of state water control, and from Elwood Mead, who pursued land and water reform during the early twentieth century.

Powell's studies on the nature of the West largely were ignored by California's miners, by its land speculators, by its railroad barons, and by those who dreamed of making the state a commonwealth of small landholders, all of whom were eager to exploit whatever scarce water was available. In Washington, the outcome of trying to satisfy such interests was reflected by the federal government's sale of 610 million acres of public land through the Desert Land Act of 1875, the Timber and Stone Act of 1878, the Carey Act of 1894, and the Newlands Act of 1902. In California, litigation sometimes resulted from water disputes. The most famous case involved Charles Lux and James Ben Ali Haggin and lasted years. Legislation that emerged from further clashes of the state's diverse peoples involved complex blending and compromise of riparian rights and appropriator rights known as the California Doctrine.

These elements mingled in the legal origins of *Bryant v. Yellen*, decided by the U.S. Supreme Court on June 16, 1980. Retired dentist Ben Yellen and his allies hoped to displace the subsidized agribusinesses that controlled the land and produced the commodities in California's Imperial Valley, and that also consumed the water brought there. Yellen hoped to replace industrial farms with smaller individual farms.

The issue before the Court involved application of a general rule of federal reclamation laws that limited delivery of irrigation waters from federal reclamation projects to single-ownership farms smaller than 160 acres. If the rule applied in the Imperial Valley, owners of more than 160 acres would be forced to sell their surplus lands at prices affordable to small farmers, and California's richest agricultural region might be transformed into a bastion of family farms. The Imperial Valley otherwise would remain the preserve of large landholders and agribusinesses.

Until 1929, the privately owned Imperial Irrigation District supplied irrigation water to the valley through its own distribution system. That year, however, the federal Boulder Canyon Project Act (BCPA), which was signed into law in 1928, became effective. Under the BCPA and contracts subsequent to it, the federal government

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agreed to construct and pay for a new irrigation system drawing water from the Colorado River. In contracting with the Imperial Valley Irrigation District, the government agreed that the provisions of the Colorado River Compact, involving seven western states, left Imperial Valley landowners with their "present perfected rights," unaffected by the 160-acre limitation. Officials of the Department of the Interior sustained that position until 1964, when it was abruptly repudiated. Repudiation at once brought Imperial Valley landowners under provisions of the 1926 Omnibus Adjustment Act, which prohibited delivery of reclamation project waters to one-owner private lands in excess of 160 acres. The repudiation prompted legal battles.

In the Supreme Court's ruling in *Bryant v. Yellen*, Justice Byron White, at times a liberal but more often a strict constructionist legal scholar, rejected the contentions of lower court rulings that would have restricted water rights of large farms. A critical section of the BCPA, White noted, stipulated that project waters were to be applied to irrigation, domestic uses, "and satisfaction of present perfected rights." Before 1929, under California law, the Imperial Valley District had supplied irrigation waters to individual farmers regardless of the size of their landholdings. Moreover, from 1929 until 1964, the Interior Department had made no effort to invoke the 160-acre limitation. Thus, in White's view, the interior secretary's reversal of long-accepted practice ignored "unavoidable limitations" imposed on his authority. Neither state nor federal laws, White concluded, sanctioned the 160-acre limitation on the perfected rights of Imperial Valley landholders.

SIGNIFICANCE

The *Bryant v. Yellen* decision legally confirmed the status quo in the Imperial Valley, a garden spot that before irrigation appeared on many maps as the Colorado Desert. The agribusiness saved by the Court was an outgrowth of the BCPA, which after 1932 brought enough Colorado River water to the valley to irrigate 440,000 acres. The prosperity that ensued raised land prices. Most small farmers sold out to wealthy purchasers, creating two classes. One has been described as an elite of large, often absentee, landholders irrigating an average of 500 acres each, in several cases nearly 10,000 acres. This group has been successfully represented through its numer-

U.S. Supreme Court Rules on California Water Rights

ous associations and its lobbyists in Sacramento and in Washington. The other class, by 1970 one of the nation's most impoverished, was composed chiefly of Chicano or Mexican laborers who maintained irrigation canals and harvested the owners' crops. The status quo thus did nothing to nurture small landholdings or to foster social reform.

What the Supreme Court decreed and agribusiness applauded, nature treated with indifference. The West, California included, remained as arid as ever in affirmation of geographic, geological, and meteorological realities. Irrespective of spectacular public and private efforts, westerners by 1990 were able to irrigate only 69,000 square miles out of millions of dry acres. Even in Utah, where Mormons had pioneered irrigation and paved the way for federal reclamation laws, the limits of assaults on nature were manifest. After heroic labors, only 3 percent of the land had been irrigated. California, despite the construction of twelve hundred dams, the creation of two of the world's largest irrigation projects, and expenditures that spiraled into the billions of dollars, had irrigated about 9,200 of its



Stationary sprinklers provide one of many methods of irrigating fields. Other methods include using mobile sprinklers, flooding furrows and entire fields, and releasing water through subterranean pipes. (PhotoDisc)

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156,537 square miles of land area. Some desert had been made to bloom, but not enough even to blemish the complexion of a vast arid region.

A California drought lasting from 1987 to 1992 drew public attention to the issues raised in *Bryant v. Yellen* and to the effects of the status quo in the Imperial Valley and elsewhere. Into the 1980's, the state had continued evasive actions to preclude application of the 160-acre limitation embodied in federal reclamation laws. During the early 1990's, Californians examined their prodigal uses of the West's most essential commodity.

State officials and the public acknowledged that water could no longer be treated as if it were virtually free. Even so, indications were that it cost less for some than for others. About 85 percent of California's water, for example, went to its farmers, mostly agribusinesses, whose products earned revenues of \$18 billion a year but constituted only about 3 percent of the state's economy. These farmers, in turn, paid only 10 percent of the cost of their water, about \$10 per acre-foot. California's cities paid up to \$200 per acre-foot. Part of the bill fell on taxpayers. Agribusinesses using the Central Valley's federal irrigation system were allowed to pay the Boulder Canyon Project's cost, interest free, over a fifty-year period. With water furnished so cheaply to them, Imperial Valley farmers lacked incentives to conserve. They had prospered from growing notoriously thirsty crops such as alfalfa, cotton, and rice, each federally subsidized (\$400 million annually for rice alone) and each a surplus crop. Few farmers drilled wells, and few tried the economical drip irrigation common in Israel and other dry parts of the world. Few bothered to prevent leakage on their lines and aqueducts.

Some experts argued that California possessed adequate water and that the problem was maldistribution. Most Californians live in the southern portions of the state and most water is in the north. Southern Californians demanded more dams, aqueducts, and canals, although during the 1990's environmental groups posed opposition. Some pointed to the availability of the huge aquifer that underlies the state, estimated in 1991 to contain 850 million acre-feet of water, for which farmers could pay as little as \$20 per acre-foot.

Tapping the aquifer at 1990 levels of usage reportedly would exhaust it within decades. Many believed in addition that continuing

the subsidization of agribusinesses' surplus crops and cattle, and thereby wasting water, was a recipe for economic and political disaster. Environmentalists refused to support expenditures for new irrigation projects. They regarded water as a finite resource that was being applied to inefficient agriculture to produce nonessential commodities. They opposed further damage to California's landscape and wildlife that would be caused by dam building and by the neutering of the soil resulting from saline deposits from irrigation reservoirs and canals.

Nothing is likely to cure California's or the West's aridity or, in the short term, drastically alter lifestyles. The coincidence in 1991 of prolonged drought and the expiration of many old water contracts favored plans to conserve and to price water realistically. Schemes were proposed to reclaim waste waters and to desalinate seawater. Southern California's Metropolitan Water District allocated \$30 million to purchase water from farmers, while Sacramento rice growers were offered \$250 an acre to save water by not growing rice. In addition, early during the 1990's the trading of water rights within irrigation projects and between cities and farmers was being explored. In 1991, Los Angeles entered into the Inyo-Los Angeles Long Term Water Agreement to address both water needs and the effects of underground pumping on affected environments. This was followed in 1997 by a Memorandum of Understanding among Los Angeles, Inyo County, the Owens Valley Committee, and the Sierra Club to restore the integrity of the lower Owens River, which had been damaged by overpumping.

Clifton K. Yearley

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■ JULY 10, 1981

BROWN ORDERS MEDFLY SPRAYING IN CALIFORNIA

Governor Jerry Brown of California alienated both environmentalists and farmers when he belatedly ordered agricultural spraying of the insecticide malathion to combat the Mediterranean fruit flies that threatened his state's agricultural produce.

LOCALE: California

AGRICULTURAL ISSUES: Chemistry; Ecology and environment; Government policy and regulation; Pests and pesticides

KEY FIGURE

Jerry Brown (b. 1938), governor of California, 1974-1982

SUMMARY OF EVENT

More than halfway through his second term in office, California governor Jerry Brown made the decision to proceed with extensive malathion spraying to combat an infestation of the Mediterranean fruit fly. In part because of governmental vacillation, the fruit fly's numbers had grown far beyond its initial small population.

The climate of Southern California is nearly perfect for the Mediterranean fruit fly, *Ceratitis capitata*, commonly referred to as the Medfly. Slightly smaller than a regular house fly, the Medfly lays its eggs in more than 250 species of fruits and vegetables. It infests a wide array of fruit, including not only oranges and grapefruits but also peaches, nectarines, mangoes, plums, avocados, grapes, coffee beans, cocoa, guava, and dates. The fly is native to not only the Mediterranean area but also the west and east coasts of sub-Saharan Africa and parts of Central and South America. The fly is not found in tropical and temperate Asia, and those countries are very aware of the potential damage it would cause there if it were to be introduced.

Adult Medflies have yellow-and-black bodies and banded, transparent wings. An adult female fly lays her eggs in groups—up to six hundred in her lifetime. Using her ovipositor, she pierces the skin of

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Succulent fruits such as peaches are especially vulnerable to medfly infestations. (Library of Congress)

the fruit, and the eggs develop in the pulp. The white-to-yellow maggots bore through the pulp of the fruit. The fly larvae grow through three stages during their ten to fourteen days inside the fruit. When fully grown, the maggots are about one centimeter long. By this time, the rotten fruit in the wild has usually fallen to the ground. The mature maggot then crawls out and forms a pupa in the soil for two weeks before it emerges as an adult fly. The total life cycle—from egg to adult—can occur in less than three weeks, or can last for more than three months, depending on climate. In warm regions, fly breeding is continuous throughout the year; otherwise, the pupal stage carries the fly through cooler weather.

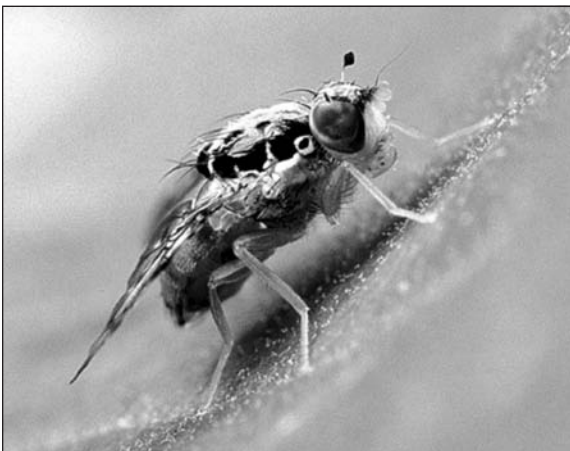
The Central Valley region of California is the most productive agricultural region in the world. California ships about one-fourth of its \$18 billion harvest abroad. If the Medfly became established in California orchards and fields, many other nations and American states would stop importing produce or demand inspection and treatment to effectively eliminate the risk of importing the Medfly. Such treatments and inspections would cost an estimated \$1 billion. An em-

bargo on California produce affected by Medfly concerns would cost an estimated \$6.2 billion. In addition, if foreign countries, especially Japan, were to switch to other markets, it would be difficult for California to regain its market after eradication was achieved. Loss of the Japanese market alone would cost California more than six thousand jobs, and if other vulnerable foreign countries followed suit, the market would drop and more than thirty-five thousand jobs would be lost. While Japan and other major Asian countries have not yet embargoed produce from California, China has quarantined California produce because of the Medfly.

Because of the extent of potential damage, traps are used to constantly monitor for the first signs of newly arrived Medflies. If these flies are found, traps are dispersed to determine the exact areas infested and are continually monitored to assess efforts to eradicate the fly. The name of the insect food lure for the Medfly is Trimedlure. Its chemical formula is precisely known: *t*-Butyl 2-methyl-4-chlorocyclohexanecarboxylate.

Quarantines are imposed immediately when the Medfly is found. Fruit cannot be moved out of infested areas, thus protecting the ability of other areas to export fruit and slowing the spread of the pest to neighboring areas.

The insecticide used to kill the Medfly adults before they lay eggs is malathion. Unlike its more potent organophosphorus-compound relatives, malathion is a weak insecticide with much reduced toxicity



Mediterranean fruit fly.
(USDA/Scott Bauer)

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for mammals. The control of muscles by nerves requires that a chemical transmitter (acetylcholine) be recycled by an enzyme (cholinesterase). The organophosphorus insecticides block this enzyme from recycling the transmitter, and the interference of the continuous signals to muscles eventually prevents vital organs from functioning; this soon causes death. This is a simplified explanation of why insects sprayed with an insecticide often “tremble to death.” Malathion is considered to be about as safe as any chemical pesticide in this class, requiring a 3,200 times higher oral dosage to produce the same toxicity as tetraethyl pyrophosphate (TEPP), a potent organophosphorus pesticide. Malathion is relatively unstable and soon breaks down rather than persisting in the environment.

Malathion is often mixed with a syrup bait or a yeast protein that attracts the fly. The Medfly is truly a fruit fly that is attracted to sugars and fermentation products. By mixing malathion with such baits, the fly is brought directly to the poison droplet, and overall malathion levels in the environment can be kept even lower. The 1981 campaign in California involved malathion applied at levels of 1.2 pounds of toxicant per acre. Helicopter spraying is generally used to assure complete coverage of the area. While the dosage is well below the allowed level—and California has the most stringent pesticide regulations of all states—this spraying is nevertheless very visible to suburbanites.

New infestations often center in Los Angeles and Orange counties. A portion of the population of California in these areas, however, is opposed to the use of pesticides and in particular the malathion sprayings that are used to depress the Medfly populations and hold the line until sterile release can be used to eradicate the fly. Objections come from many sectors. Some opponents are concerned that the health effects of malathion are not yet well known and may pose a danger to both humans and pets. Because the Medfly repeatedly reinfests the area, some contend that the pest is a permanent resident and should be controlled with natural parasites and beneficial insect predators. Some people contend that the Medfly could not survive in the adjacent Central Valley. Entomologists and government officials, however, are far less certain that the fly could be contained, and they note that California produce would most definitely be quarantined both by other states that are not infested and by foreign importers, particularly Japan.

In the cases in which local officials and city councils have fought the spraying efforts, the governor has declared a state of emergency for infested areas, allowing the California Department of Food and Agriculture to ignore the local restrictions.

SIGNIFICANCE

U.S. customs inspectors had long recognized the danger of importing this damaging fruit fly. The first infestation to gain a foothold in the United States was discovered in Florida in 1929. It was rapidly exterminated, and it was not until 1956 that another infestation was discovered near Miami. Increases in international travel and shipments have accelerated the risk of reintroductions.

The first Medfly infestation in Southern California was discovered in 1975. The extensive 1980 to 1982 infestation was eradicated, and California was essentially free from the pest for five years. The Medfly showed up again, however, in 1987 and in many of the years since then.

Unlike pesticides that may miss pockets of infestation and that may lead to survival of resistant strains of pests, sterile release is a proven technique that has the potential to drive certain insect populations into local extinction. Fruit flies are good candidates for eradication by sterile release, because they can be raised in large numbers in the laboratory and be subjected to high dosages of radiation. This produces seemingly normal but sterile fruit fly adults that are incapable of successfully fertilizing wild flies when released. Sterile flies must be released in numbers that swamp the wild fly population so that most fertile wild flies mate with sterile flies and lay infertile eggs. When this process is repeated for several generations, the wild fly population drops until the few remaining female flies all mate with sterile males and the population goes extinct locally.

Early experiments with sterilized Medflies in Hawaii in 1959 and in Costa Rica in 1963 showed success despite being held in regions where constant reinfestation kept the pest from being eradicated. Some insects, such as screwworm flies that mate only once and are easily sterilized by radiation without affecting mating behavior, are easily driven to local extinction with the technique. The technique is not effective on other insects such as mosquitoes, because they mate many times, are weakened by irradiation, or have other biological

complications. The Medfly appears very vulnerable to sterile release, and the technique has been repeatedly successful in wiping out infestations in Florida. In at least one instance, however, the California Medfly sterile-release program may have suffered a setback when fertile male flies contaminated the sterilized factory flies being released.

The technique cannot work if Medfly populations soar to high levels and the natural fertile flies vastly outnumber the sterile flies scientists introduce. Generally, the ratio of sterile-to-wild flies must be between 10-to-1 and 100-to-1. Therefore, to assure a heavy supply of sterile flies, the sterile-release effort has to be coordinated with the laboratories located in Hawaii and Mexico that raise and sterilize the flies. If the infestation is allowed to spread over a larger area, far more sterile flies are needed. This is where malathion spraying comes in. When an infestation has just started and is isolated in a small area, the state agriculture department can usually use one malathion spraying to knock it down to a small level and finish the population off with sterile release. The California outbreaks, however, have often been unusually extensive by the time they are detected; multiple sprayings in such cases are necessary. Shortages of sterile flies have extended Californian spraying to several months. The best mode of application has proven to be nighttime aerial spraying from helicopters flying at an altitude of about five hundred feet. Not only is the dispersal of spray more effective from the air, but also the nighttime schedule ensures that far fewer people will be covered by the dilute spray.

California is not the only U.S. port of entry for the Medfly. As a citrus state, Florida also has a tropical climate and carefully monitors for the pest. When one fly was found near Miami International Airport in 1990, Florida spent about \$1.5 million to spray and eliminate the fly from a twenty-square-mile area. Control in California, however, has been much more problematic. The infestations between 1980 and 1982 cost the state and federal government \$100 million for control, and farmers suffered another \$100 million in crop losses. Spraying was required over a region of some five hundred square miles, spanning dozens of local communities and resulting in several hundred damage claims or lawsuits. California maintains a State Medfly Science Advisory Panel for science input to the state problem; a recent chairperson of this panel stated that, in both 1980 and 1989, the state waited too long to begin the eradication program.

The environmental sector consistently is on the lookout for biological control agents to combat the Medfly and has been overly optimistic in promoting these safe miracle cures. Some biological agents, such as the nematode parasite called the Mexican roundworm, have impressive records of depressing Medfly populations in some tests. The roundworm, however, only attacks larval Medflies and does not affect pupae. The populations of parasites cycle with the abundance of hosts. Because the Medfly is so devastating to agriculture, there is essentially a zero-tolerance level: Any survival of the pest would allow its exportation with produce and would have disastrous consequences for other regions.

The ongoing Medfly dilemma contributed to the withdrawal of some political support for Brown. As California governor, Brown had tightened air-quality standards and had reduced air pollution by 25 percent, had created an energy commission that blocked construction of nuclear power plants, and had established a California Conservation Corps. In spite of his substantial environmental record, the Medfly dilemma that occurred late in his second term as governor placed Brown in the middle of a dispute between environmental extremists who considered any pesticide spraying to be dangerous and farmers who were facing economic disaster.

From both scientific and political perspectives, Brown delayed aerial spraying too long. By the time Brown authorized the necessary spraying, he had lost support from both camps. In spite of a drop in his popularity with voters, which involved other issues as well, such as school and highway finance, Brown ran against Pete Wilson in 1982 for a seat in the U.S. Senate and lost. Succeeding California governors George Deukmejian and Pete Wilson both had the advantage of seeing the consequences of Jerry Brown's ambivalence when immediate spraying campaigns were needed. As long as wild populations of the Mediterranean fruit fly exist, however, the continued import of illegal fruits and vegetables, mostly in airline passengers' travel luggage, will doubtless continue to pose the threat of new outbreaks.

John Richard Schrock

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■ JUNE, 1982-AUGUST, 1983, AND EARLY 1997-
AUGUST, 1998

EL NIÑO WEATHER DEVASTATES PACIFIC BASIN AGRICULTURE

During the early 1980's and again during the late 1990's, the term "El Niño condition" entered the language as unusually severe weather conditions originating in the Pacific Ocean brought storms and heavy flooding to the islands and continents rimming the ocean, killing thousands of people, causing billions of dollars in property damage, and devastating agriculture, livestock, and fishing industries.

LOCALE: Equatorial Pacific Ocean and bordering continents

AGRICULTURAL ISSUES: Climate change; International food relief;
Natural disasters; Tropical produce

SUMMARY OF THE EVENTS

Before 1982, "El Niño" was a term known almost strictly to scientists studying the ocean, atmosphere, and weather. After 1983, so widespread and serious were El Niño's destructive consequences, the phenomenon became known worldwide as the largest force disrupting world weather patterns.

The El Niño of 1982 developed anomalously. Previous El Niños had begun in April with waters warming off the Peruvian coast and spreading westward. In this case the temperature rise started in the central Pacific and flowed eastward in June and August, and the barometric pressure increased in the western Pacific. Moreover, while the warm water moved slowly eastward toward South America, the westerly trade winds continued blowing unabated; normally they weaken. Volcanic dust lofted into the atmosphere from the eruption of El Chichón in Mexico masked some of these developments from satellites, and partly because of this, the beginning of a full-blown El Niño in November took observers by surprise. Before it ended in August, 1983, five continents had suffered its devastating effects.

Its intensity was unheralded. The Southern Oscillation—indicated by the difference in air pressure between Darwin, Australia, and Ta-

JUNE, 1982-AUGUST, 1983, AND EARLY 1997-AUGUST, 1998

hiti—was never before so great. Sea surface temperatures off the South American coast soared to almost 46 degrees Fahrenheit (8 degrees Celsius) above normal, another record. The mass of warm water increased evaporation, which fueled storms that lashed the coasts and Pacific islands near the equator.

Six hurricanes swept over Tahiti and nearby Tuamotu archipelago in the central Pacific; the area had not seen a hurricane for seventy-five years. More than 7,500 houses were flattened or lost their roofs, and 15 people died. The destruction ended tourism for the season, a main source of income. A hurricane also hit the Hawaiian Islands, which otherwise had a drought. Elsewhere in the Pacific scientists noticed that millions of seabirds deserted their nests and the warm water damaged reefs.

Ecuador and Peru were first hurt economically, then physically. The planktonic nutrients that normally rise from the seafloor with upwelling cold currents dwindled when El Niño's warm water arrived. Schools of commercial fish vanished. Fishermen were idled, as were industries dependent upon fishing, such as fishmeal production. Because the coast of both countries is very arid, when El Niño-spawned storms arrived, their torrential rains turned into floods that swelled rivers and raged through canyons. As a result, thousands of houses, mostly in rural towns or urban slums, were washed away,

EL NIÑO CONDITIONS

El Niño is a recurring weather phenomenon involving large-scale alterations in ocean surface temperatures, air pressure, and precipitation patterns in the Pacific Ocean. It can cause severe storms and droughts in the bordering continents and has effects worldwide. Its name comes from the Spanish words *El Niño*, for "the boy," which allude to the infant Christ. It is the traditional term used by Peruvian fishermen to refer to a slight warming of the ocean during the Christmas season. Scientists borrowed the name and reapplied it to abnormal, irregularly recurring fluctuations in sea surface temperature, air pressure, wind strength, and precipitation in the equatorial Pacific Ocean. These conditions are part of a weather phenomenon that scientists call the El Niño-Southern Oscillation (ENSO). El Niño conditions can last up to two years.

along with sections of roads and more than a dozen major bridges. At least 600 people were killed in the process. Important export crops—particularly rice, cacao, and bananas—also were heavily damaged, further crippling the national economies.

The west coasts of Central and North America soon experienced similar conditions. California was especially hard hit. Salmon and other cold-water fish departed north, hurting the local fishing industry, while seabirds died and tropical fish, such as barracuda, invaded the coastal waters. High sea levels, as much as 8 inches above normal, combined with storm-propelled waves, battered the coast. Wind gusts damaged houses, and a tornado even tore the roof off the Los Angeles Convention Center before ravaging the Watts district. Rain fell until rivers overflowed and hillsides were so soaked that mudslides occurred at record rates. In the Sierra and Rock Mountains, snowpacks reached record depths. Altogether, more than 10,000 buildings were damaged or destroyed, and the economic toll on the West Coast, which included extensive damage to roads and agriculture, was estimated at \$1.8 billion. Meanwhile, in the American South, heavy rains fell, nearly pushing the Mississippi River over its levees. The Atlantic hurricane season, however, was short and mild.

Across the Pacific, under the abnormally high pressure over the Indonesia-Australia region, conditions were dry. The drought in Australia starved thousands of livestock and wild animals and turned brushland parched and dusty. Immense dust storms dumped tons of dirt on cities, Melbourne most spectacularly, and brush fires raced out of control. At least eight thousand people were made homeless in the fires, and there were seventy-five fatalities. Late in the El Niño, downpours in eastern Australia led to flooding that drowned yet more livestock. Indonesia saw crops fail in the drought. In one area 340 people starved because of it. On the island of Borneo, forest fires, spread from land burned off by farmers, expanded unchecked. The smoke fouled cities, endangered air traffic, and caused one port to close temporarily. The fires were called one of the worst environmental disasters of the century,

Record drought also came to Africa, hurting the southern and Sahelian regions most. In some areas of South Africa 90 percent of cattle died as the grassland turned to barren hardpan. Tens of thousands of wild animals, from rodents to elephants, perished. To escape

famine, the poor countries of the region had to rely on food shipments from North America. Many other effects, such as delayed monsoons in southern India and droughts in Brazil and Mexico, were teleconnections to El Niño. Scientists suspect that a cold snap in Europe and droughts in the Midwest, northern China, and central Russia might also have occurred because of El Niño, at least in part.

Early in 1997, scientists detected a large pool of abnormally warm water in the southwestern Pacific. As it spread eastward along the equator, they knew what it meant—a developing El Niño. They could also predict its likely career, thanks to more than two decades of intense research and improvements in computer weather modeling. Accordingly, many of the countries that had suffered from earlier El Niño weather conditions made preparations. Nevertheless, the 1997-1998 El Niño's strength surprised forecasters and overpowered most precautionary measures.

By August, sea surface temperatures were as high as they had been during the region's 1982-1983 El Niño, and forecasters began to expect the worst. In October, the pool of warm water swelled to an area larger than that of the United States. In early November, with ocean temperature nearly 46 degrees Fahrenheit (8 degrees Celsius) above normal, heavy storms began to gather and blow ashore along the North American, Central American, and South American Pacific coastline.

Stung by losses during previous El Niños, Peru had borrowed \$250 million and Ecuador \$180 million to pay for disaster relief supplies and construction. They cleared out waterways, built dikes, and shored up bridges. Despite these preparations, the two countries were again devastated. More rain fell in Ecuador than during the record deluges of 1982-1983. Nineteen bridges were washed out, and more than 1,554 miles (2,500 kilometers) of roadway were damaged. In some areas transportation was cut off completely, disrupting commerce. Flooding left 50,000 people homeless, many of them in poor towns and slums on the outskirts of cities. Fouled water sources spread diarrheal diseases.

In Peru, conditions were even worse. About 373 miles (600 kilometers) of roadway and 30 bridges were rendered impassable because of floods inland, while the south coast, which forecasters expected to remain dry, was also flooded. In the north the Sechura

Desert turned into a vast shallow lake. Rain soaked the Andean foothills, and the consequent landslides were deadly. In one slide, 20 people died. More than 350,000 people eventually lost their homes. The destruction to agriculture and the collapse of the anchoveta fishery offshore left many more without a livelihood.

Just south of Peru, Chile's Atacama Desert, the driest place on earth, erupted in flowers after the rainfall, and the increased snowpack in the Andes gave the country its longest skiing season on record. Chile also suffered, however: Crops were destroyed, and 80,000 people became homeless because of flooding. Flooding in Argentina, especially along the Paraná River, cost the nation \$3 billion in lost crops—40 percent of its cotton, 30 percent of its rice, and 50 percent of its tobacco—and left 150,000 homeless. Brazil lost even more in cattle and withered crops as drought came to its northeast. Drought also plagued Venezuela, Guyana, and Suriname. Receiving half its normal rainfall, Columbia lost 7 percent of its agricultural output.

Central America suffered similarly. Drought ruined 30 percent of El Salvador's coffee and 10 percent of Guatemala's grain. Water levels were so low in Panama that shipping was restricted through the Panama Canal, which cut into the nation's principal revenue source, and electrical output from hydroelectric plants declined. Mexico, as well as having drought in some areas, was lashed by three powerful hurricanes. One that came ashore at Acapulco leveled sections of the city, ending tourism for the season and idling 150,000 workers. The Caribbean was short of rain, causing forest fires in Cuba to burn out of control; some eastern Caribbean islands had to ration water.

North America (as well as Europe and eastern Asia) saw unusually warm weather, including the hottest February on record. As during the 1982-1983 El Niño, the West Coast, California especially, received storms with exceptionally heavy rain. During a nine-hour period in December, 1982, for example, the state's Orange County received 8 inches of rain, and the resulting flood did an estimated \$10 million in property damage. Elsewhere roads washed out, and bridges crumbled. The Sierra Nevada accumulated a deep snowpack, raising the possibility of spring flooding. On the coast, seabirds and seals starved because their prey, fish, had fled the warming seawater. Meanwhile, far to the north, near Alaska, fishers were hauling in tuna and sunfish

JUNE, 1982-AUGUST, 1983, AND EARLY 1997-AUGUST, 1998



Papua New Guinea villagers carrying sacks of rice delivered by Australian military units to help relieve the food shortage caused by El Niño-related drought conditions. (AP/Wide World Photos)

and spotting great white sharks, all of which normally swim the Southern Californian waters.

Across the Pacific Ocean, drought parched the western Pacific islands. The Philippines endured the worst dry spell in four decades. It ruined rice crops, killed off livestock, and sent thousands of farmers to cities looking for jobs. Indonesia, however, was the site of the most influential calamity. Farmers there burn off new fields every year and expect the seasonal rains to put out the fires. In 1998, the rains failed to come. The field burns escaped into forests and burned out of control for weeks. The smoke drifted throughout the region, so intensifying the smog in some cities that businesses and schools closed. The smog caused an airline crash that killed 234 passengers. The fires and the drought damage to crops brought \$1.3 billion in losses and serious food shortages, contributing significantly to the Asian economic crisis.

SIGNIFICANCE

In addition to bringing the El Niño phenomenon forcefully to public awareness, the 1982-1983 El Niño event had three consequences. It

spurred much scientific research aimed at making predictions of future El Niños reliable. It encouraged farmers in affected areas to reconsider how they manage their crops and livestock. Finally, it demonstrated dramatically that coastal cities, which are growing increasingly crowded, are vulnerable to El Niño-related natural disasters.

By the time the pool of warm water receded in August, 1998, the 1997-1998 El Niño had already become the most studied weather phenomenon in history— “the climate event of the century,” in the words of U.S. vice president Al Gore. Scientists wondered if the 1997-1998 event was evidence that global warming would eventually fuel even more powerful El Niños.

Roger Smith

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■ JANUARY 11, 1983

U.S. GOVERNMENT PAYS FARMERS NOT TO PLANT CROPS

Under a payment-in-kind program, American farmers who agreed not to plant portions of their land were paid with government surplus commodities. The program had wide-ranging effects, including increased crop production in other countries.

LOCALE: Washington, D.C.

KEY FIGURES

John Block (b. 1935), U.S. secretary of agriculture, 1981-1986

William Lesher (b. 1946), assistant secretary of agriculture for economics under Block

Dan Amstutz (b. 1932), undersecretary of agriculture for international affairs and commodity programs under Block

Bob Dole (b. 1923), U.S. senator from Kansas

AGRICULTURAL ISSUES: Government policy and regulation; Price supports and controls; Textile industries

SUMMARY OF EVENT

The U.S. Department of Agriculture (USDA) established and administered the payment-in-kind (PIK) program under the statutory authority granted by the Agricultural Act of 1949, as amended, and the Commodity Credit Corporation Charter Act. The PIK program thus was designed and implemented within existing statutory authority but did not receive specific congressional authorization. The program was offered to farmers who agreed to reduce their planting of wheat, feed grains (primarily corn and grain sorghum), rice, and upland cotton beyond what was called for in the 1983 programs for those crops. The basic concept behind the program was that farmers were offered commodities as payment for reduction of this additional acreage.

Historically, the USDA has used a number of production adjustment mechanisms to take cropland out of production. These mecha-

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nisms are part of a group of farm programs designed to stabilize and enhance commodity prices and farm incomes. The Agriculture and Food Act of 1981 authorized cropland reduction programs for the 1981-1985 crops of wheat, rice, cotton, and feed grains.

The USDA administers these farm programs through its Commodity Credit Corporation (CCC) and its Agricultural Stabilization and Conservation Service (ASCS). The CCC is a government-owned and -operated corporation created in 1933 to stabilize, support, and protect farm income and prices; to assist in maintaining balanced and adequate supplies of agricultural commodities; and to facilitate the orderly distribution of these commodities. The CCC also encourages farmers to store commodities when stock levels are higher than needed to meet foreign and domestic demand. The CCC has no operating personnel. Its programs are carried out primarily through the personnel and facilities of the ASCS.

Despite the commodity programs that were in place, a number of trends began to evolve during the early 1980's that made these traditional approaches ineffective and costly means of controlling surplus



Mechanization of American agriculture—evidenced by machines such as these that have eliminated the tedium of picking cotton by hand—have made it possible to increase production well beyond national needs. (PhotoDisc)

agricultural commodities. In testimony before the U.S. House of Representatives on December 16, 1982, Secretary of Agriculture John Block outlined some of the factors that had come together to cause the downward pressures on prices and income that farmers were experiencing during the early 1980's. The first of these was a large global supply of crops, a result of record world production of grains, oilseeds, and cotton in the preceding several years. The United States alone was holding about 150 million tons of grain stocks, equivalent to approximately 60 percent of the world's carry-over and more grain than the country exported annually.

The Soviet grain embargo of 1980-1981 had been imposed in response to the Soviet invasion of Afghanistan. This embargo cost the United States a major market, as the country came to be viewed by the Soviets as an unreliable supplier. The share of grain imported into the Soviet Union from the United States fell from 70 percent to 30 percent. Other major exporters gained at the expense of the United States: Canada's share of Soviet imports doubled, Australia's tripled, and Argentina quadrupled its grain sales to the Soviet Union.

Concurrently with record world production of grains, oilseeds, and cotton, demand had been weak. World use of feed grains had been growing at a rate of sixteen million metric tons per year during the previous twenty years, but use of feed grains had not increased for the preceding four years. In a similar vein, world wheat consumption had been increasing by ten million metric tons per year from 1960 to 1980 but had been flat since. To compound matters, the value of the U.S. dollar relative to ten major currencies was at its highest level since 1969. This increased the price of U.S. commodities in terms of foreign currencies despite the decline in prices in U.S. dollar terms.

Secretary Block cited the fact that many exporting countries competed unfairly through the use of subsidies and other impediments to trade. In particular, the European Community spent \$6 to \$7 billion annually on export subsidies. In addition, financial problems in Poland, Romania, Mexico, Brazil, Portugal, and other middle-income countries that represented a significant portion of the foreign demand for U.S. farm products had adversely affected export potential.

These elements had combined to produce huge stocks and weak demand, with prices falling as a result. Farm program expenditures



Farmers cutting sorghum cane to make syrup. (Library of Congress)

had therefore increased drastically. In fiscal year 1980, expenditures were \$2.7 billion, and in fiscal year 1982, expenditures were \$11.6 billion. By 1983, federal outlays were \$18.9 billion, a sevenfold increase from 1980. Because of this situation, the USDA had some difficult decisions to make regarding the final 1983 program.

During Ronald Reagan's presidency, the federal government's approach to improving price and farm income prospects for future years was to take action so as not to fall victim to the temptation of legislating near-term prosperity through higher price supports or other rigid nonmarket actions. Officials thought that yielding to this temptation would only encourage farmers to produce more, in response to artificially high prices, at a time when the market was strongly signaling the need for less.

The Department of Agriculture introduced the payment-in-kind program to rectify the situation. William Leshner, assistant secretary of agriculture for economics, and Dan Amstutz, undersecretary of agriculture for international affairs and commodity programs, were both instrumental in developing aspects of the program. The USDA had a

number of reasons for selecting the PIK program to address the situation rather than expanding its acreage reduction program (ARP) or its program of paid land diversion (PLD), both of which paid farmers to take land out of production and thus reduce their harvests. First, paying farmers in commodities for idling acres would not significantly increase farm program budget outlays in the short term. The commodities used to make payments would be those acquired by the CCC or farmer-owned commodities held by the CCC under price-support loans. These commodities had already been paid for. A second rationale was that “paying” farmers with these commodities would reduce the surplus stocks, and USDA storage payments on these commodities would decline. Finally, the USDA did not constrain PIK payments to the \$50,000 limit that individual farmers could receive under other farm programs. The intended result was that large farmers who restricted their participation in ARPs in the past because of this limitation would participate more fully in the PIK program.

The USDA instituted the PIK program with the following objectives: to reduce production of wheat, corn, grain, sorghum, cotton, and rice; to reduce these commodities’ total ending stock levels; to ease commodity storage problems; to ensure adequate supplies of commodities; to increase net cash farm income; and to minimize government farm program outlays over the long term. Even though the program did not require new legislation, it was given strong support on Capitol Hill from Bob Dole, a politically influential senator from Kansas with a large agricultural constituency.

SIGNIFICANCE

The PIK program removed an additional 49.2 million acres of cropland from production in 1983 beyond the 26.8 million acres that would have been taken out under previously announced farm programs. Determining the impact of the PIK program is complicated because of a drought that occurred during the summer of 1983. The drought’s effects were especially severe because of when and where it happened. It occurred toward the end of July and August, the prime growing season for such major crops as corn and grain sorghum, and was most severe in the top crop-producing states of Illinois, Iowa, Kansas, Missouri, and Oklahoma.

It is interesting to note that the drought had effects similar to those of the PIK program. It contributed to reduced production of some PIK commodities, especially corn and grain sorghum. This reduced production resulted in reduced total ending commodity stock levels and further eased storage problems for PIK commodities. The drought also contributed to increased commodity prices, which increased farmers' net cash incomes in 1983. Consequently, to determine the PIK program's impact as it related to the broad objectives the USDA had established, it is necessary to isolate the impacts of the PIK program from those of the drought.

The U.S. General Accounting Office performed an analysis regarding the design, impact, and cost of the PIK program. Its findings indicated that the PIK program and the drought had the following effects. Production of the five PIK commodities fell by about 35 percent, with 18 percent of the reduction attributable to PIK and 17 percent to the drought. Total ending stock levels of PIK commodities fell by about 62 percent, with 35 percent of the reduction attributable to PIK and 27 percent to the drought. Storage problems for the USDA were eased by reducing PIK commodities held under government loan and government ownership by about 75 percent, with 43 percent attributable to PIK and 32 percent to the drought. Stock levels of corn and cotton at the end of 1983 were short by about one billion bushels and 500 million pounds, respectively, of those considered necessary to ensure sufficient carryover levels. PIK and the drought combined to cause the corn stocks to be short, but PIK alone caused the cotton stocks to be short. Net cash farm income rose by about \$12 billion, with about \$9.2 billion attributable to PIK and \$2.8 billion to the drought.

The USDA estimated that the program cost approximately \$10 billion. These costs included the cost of the commodities, storage payments made to farmers, diversion payments made to farmers for taking a certain percentage of their cropland out of production, distribution costs for PIK commodities, and potential interest forgiven for loans that farmers had received on crops. The cost of commodities was almost 90 percent of the total. Participation in the program included 831,751 farmers, 93 percent of whom were individuals and 7 percent of which were corporations or partnerships. The average PIK payment per farmer was \$10,627.

One of the major impacts of the PIK program occurred to farm-support industries, including those producing farm equipment, seed, and fertilizer. On February 21, 1984, Agriculture Secretary John Block testified before the Agriculture Subcommittee of the U.S. House of Representatives Committee on Appropriations regarding the impact on the input supply industries. He indicated that unit sales of major production items such as seed, fertilizer, pesticides, and farm machinery were down 10 to 15 percent overall in 1983 compared to 1982, and down 20 to 30 percent for PIK crops. Total expenditures for these items were estimated to have dropped about \$5 billion, with most of the difference attributed to PIK. Machinery sales were depressed by the drought as well as by PIK. Before the drought took effect, machinery sales had been increasing.

A number of foreign countries expanded crop production as a result of the U.S. PIK program. Total foreign wheat production in 1983 increased by 4.5 percent. Production by major competing countries (primarily Australia and Canada) increased by 8.5 percent, and production by the major importers increased by 2.4 percent. Total foreign rice production increased by 4.4 percent in 1983. Major competitors increased output by 2.4 percent, and production by major importers decreased by 0.6 percent. Total foreign corn acreage in 1983 increased by 4 percent. The area planted in corn by major competing nations actually decreased by 2 percent, while major importers increased acreage by 6 percent.

John C. Foltz

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■ MARCH 10, 1984

WILLADSEN CLONES THE FIRST FARM ANIMAL BY NUCLEAR TRANSFER

Steen M. Willadsen improved on an earlier technique of cloning large mammals by developing a simple, easily used new method, making it possible for greater numbers of scientists to produce genetically identical animals for use in experimentation. The technique had far-reaching implications for animal husbandry.

LOCALE: Cambridge, England

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Genetic engineering; Scientific research

KEY FIGURES

Steen M. Willadsen (b. 1944), veterinarian who developed cloning methods

R. A. Godke (fl. late twentieth century), animal physiologist who collaborated with Willadsen

C. Polge (fl. late twentieth century), animal physiologist who assisted Willadsen in studies of embryo division and growth in cows

J. P. Ozil (fl. late twentieth century), French scientist who led a team working on splitting cow embryos to produce identical twins

Steven A. Voelkel (b. 1957), reproductive physiologist who produced the first bisected embryo twin lambs in 1984

SUMMARY OF EVENT

Steen M. Willadsen and R. A. Godke reported in the March 10, 1984, issue of the journal *Veterinary Record* on their development of a new simplified technique for the rapid production of split embryos in sheep. This procedure improved on a previous splitting method first developed by Willadsen in 1979, which required several steps occurring over about three days. As with earlier techniques in use at the time, such splitting produced two separate embryos from a single embryo collected from a mother ewe. The resultant half embryos, called demi-embryos, were then implanted into the mother's or a different

ewe's reproductive tract to allow for the development of identical twin lambs. The new procedure was considerably simplified, as it required only a single surgery on the mother, and the two demi-embryos were reimplanted into the same ewe within about an hour of the removal of the original embryo.

Work had been done since the 1950's in removing embryos from both laboratory animals and large domestic animals and then alternatively replacing them, transferring them to new host mothers, or freezing them for storage and later transfer. During the 1970's, this research led to the development of methods of separating the individual cells (blastomeres) from early two-cell, four-cell, or eight-cell embryos to allow the production of multiple individuals from the same original embryo. Such production of identical twins, triplets, and higher multiples is a means of artificial cloning. Work in this area was important to reproductive physiologists interested in how embryos develop, to researchers in other fields who needed twins for experiments in various areas, and to farmers and ranchers who wanted to increase the number of specifically bred animals.

In 1979, Willadsen published the description of his original method for micromanipulation of sheep embryos to divide an embryo in half at the two-cell stage. He first treated female sheep with hormones to cause superovulation (the production of more than the normal number of ova). The sheep were mated, and Willadsen surgically removed fertilized ova in the second day of the estrus cycle, when each embryo contained only two cells. Using a microscope, he held the embryo stationary with a capillary pipet and tore into the zona pellucida, the tough, clear outer coating that protects a mammalian egg. He separated the two cells and placed each into a new empty zona that had been collected previously. He then coated the demi-embryos with agar, a jellylike material derived from seaweed, to protect them within the torn zonas. A second layer of agar was used to coat the first, producing a small plug containing the two demi-embryos from a single original embryo.

Each cylinder produced in this manner was transferred into the oviduct of a recipient ewe that was synchronized at the same point in its estrus cycle as the mother, and the oviducts were ligated (tied off) to prevent the loss of the agar plug. After two and one-half days, the embryos were flushed out of the host mother's oviduct and evaluated

MARCH 10, 1984

microscopically. Small hypodermic needles were used to manipulate the embryos out of the agar, and the freed structures were transferred to other synchronized ewes. Sixteen sets of monozygotic (identical) embryo pairs were produced in this way, and both embryos of each set were transferred into the same host mother. Ten of the ewes carried the resultant pregnancies to term, resulting in the birth of five single lambs (when only one of the demi-embryos survived) and five sets of monozygotic twin lambs.

Willadsen also found in 1980 and 1981 that embryos could be split in half or in quarters at both the four-cell and eight-cell stages of development, and the resultant demi-embryos were able to produce normal offspring. This was shown by production of identical quadruplets in sheep in 1980 and in cattle (work that Willadsen conducted with C. Polge) in 1981. For this work, the same agar technique was used, with the embryo divided into halves or quarters. Identical twins, triplets, or quadruplets were produced in these studies. Single cells (blastomeres) derived from eight-cell sheep embryos also were able to develop into lambs, but the recovery rate was very low, and either no offspring or only one lamb resulted from each of numerous attempts.

Other investigators in this area were also working on producing cloned animals. J. P. Ozil and his colleagues in France thought that Willadsen's agar-coating method was more complex than necessary and devised a technique that eliminated that aspect of the procedure. In experiments with cattle, they used later-stage multicellular embryos, called gastrulas, and omitted the protective agar-coating step. With no agar around the embryos, it was not necessary to retrieve them three days later to scrape off agar so that implantation could take place in the host mother's uterus. In this process, the demi-embryos were separated microsurgically and then placed in empty zonae. These "naked" demi-embryos were inserted directly into the synchronized host-mother recipients, with resultant rates of pregnancy (64 percent) and of twinning (67 percent) that were lower than Willadsen's rate in sheep (75 percent), but still reasonably high.

Willadsen decided in 1984 to try the later, multicellular embryos as the source of demi-embryos. Rather than collecting embryos at day two of the estrus cycle, in the two-cell stage, or day three, in the



Cows cloned by American researchers working for Advance Cell Technologies in 2000. (AFP/Getty Images)

four-cell or eight-cell stage, the new method reported by Willadsen and Godke harvested embryos at day six, seven, or eight of the cycle. At day six, a sheep embryo is in the morula stage of development, and at day seven or eight, it is in the blastocyst stage. At these stages, there are hundreds of small cells, and the zona pellucida has disintegrated, no longer necessary for protection. Two specific areas develop in the blastocyst: an inner cell mass that becomes the actual individual and the outer layer (trophectoderm) that forms fetal membranes that attach to the mother's uterus.

In Willadsen's new procedure, these embryos were collected surgically and then cut in half using a capillary pipet and a fine glass needle. The hollow ball of cells was held so that the inner cell mass was at the top, and division was accomplished by passing the needle into the ball and moving it up and down to divide the embryo, cutting it against the pipet. The two demi-embryos were not exactly the same, but each contained about the same amount of inner cell mass and trophectoderm, enough to produce a new individual. The mother ewe from which the original embryo was taken remained under anesthesia for approximately an hour while the procedure was per-

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formed, then the two resultant demi-embryos were replaced into her uterus.

This rapid removal, bisection of the embryo, and replacement was much more efficient than the previous method. Of the eighteen ewes implanted with a pair of demi-embryos, pregnancy continued to term in sixteen ewes (85 percent pregnancy). Seven produced single lambs, one produced nonidentical twins (one lamb was from an embryo that had not been recovered and split), and eight produced identical twins (50 percent twinning). All twin production was from the bisection of blastocysts, with no twins developing from morula-stage embryos. Unpublished studies in cattle by Willadsen and colleagues also showed high viability of similarly split and transferred embryos.

SIGNIFICANCE

A major reason Willadsen's original technique was important was that it made increased numbers of genetically identical animals available for use in experimental studies. Such animals are desirable research subjects because scientists can assume that differences in responses to particular treatments are the result of the treatments and not of genetic differences between test organisms. It had been estimated that the use of one pair of twins in an experiment in cattle, as the experimental animal and its untreated control, was the informational equivalent of using twenty-two unrelated animals under the same experimental conditions. Identical twins occur naturally in cattle and sheep very infrequently, in less than 1 percent of births, and such births occur at random in the population. Willadsen's method of producing identical twins from specific animals and specific matings was able to increase the accuracy and efficiency of experiments and greatly reduce the number of animals needed to obtain useful results.

Willadsen recognized that his earlier technique was rather complicated for general use in the burgeoning market for production of twin cattle and sheep, because production was desired on the ranch as well as in the laboratory. Use of the agar-coating method required that the user be experienced in embryo transplantation and in micromanipulation for division of the original embryo. The publication of the simplified new procedure provided a significant improve-

ment over the previous method, making it possible for even relatively inexperienced users to produce reasonably successful results in twin production. The procedure developed by Willadsen opened up the production of identical twins in sheep and cattle to many more research investigations and agricultural uses.

Not only did it become possible to produce twins for use in experiments, but it also became easier to produce many offspring of a desirable mating. Through superovulation of the mother before mating, cloning of the resultant embryos, and implantation of the demi-embryos into host mothers, the actual mother could then be used repeatedly for ovum production, rather than being pregnant herself. Many offspring could be produced in this way for use in experiments or for agricultural applications, such as further breeding or milk or meat production.

Another use of the technique was that one of a pair of demi-embryos could be transferred to a host mother immediately, while the other was placed in frozen storage and later thawed and implanted. One of Willadsen's published research reports includes a photograph of identical twins produced in such a way, with one of them two weeks old and the other two and one-half months old. Such methods allow scientists to carry out an experiment on genetically identical individuals at the same time, but with the individuals at different ages.

The embryo-splitting technique developed by Willadsen soon became widely used in agriculture. Researchers such as Steven A. Voelkel and Godke in Louisiana began using it in 1984 in studies on cattle, sheep, and pigs. Voelkel was involved in the development of a modification of the technique that allowed automatic splitting of the embryo using a micromanipulator. At Southwestern Louisiana University's animal research center, the method was also applied to the embryos of rhesus monkeys in an attempt to develop a colony consisting of identical twins for use in research. Given that monkeys are closely related to humans genetically, such a colony would be of great help in studies related to human health, such as development of vaccines against malaria and acquired immunodeficiency syndrome (AIDS).

Jean S. Helgeson

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■ 1985-1987

BURGER KING BOYCOTT CALLED TO PROTECT RAIN FORESTS

In an effort to protect tropical rain forests against the expansion of cattle pasture land, the Rainforest Action Network, a U.S. environmental group, organized a boycott of Burger King restaurants to bring pressure to end imports of tropical beef.

LOCALE: United States; Central America; South America

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Diet, nutrition, and cuisine; Ecology and environment; Marketing and trade

KEY FIGURES

David Brower (1912-2000), founder of Friends of the Earth and the Earth Island Institute, parent organizations of the Rainforest Action Network

Randall Hayes (fl. late twentieth century), director of the Rainforest Action Network

Charles Olcott (fl. late twentieth century), president of Burger King who ended the company's acquisition of beef from rain-forest ecosystems

Antonio Alvarez (b. 1958), minister of agriculture of Costa Rica

Guilherme de La Penha (fl. late twentieth century), director of the Emilio Goeldi Museum in Belem do Para, Brazil

SUMMARY OF EVENT

On July 24, 1987, the *Tico Times*, an English-language newspaper in Costa Rica, published a short article titled "United States-Costa Rica 'Hamburger Connection' Broken." This article heralded the end of a boycott of Burger King, the second-largest chain of fast-food restaurants in the United States, that had begun more than three years earlier, on April 14, 1984. In 1985, the Rainforest Action Network, a non-profit, tax-exempt organization, was spun off from the Earth Island Institute, an environmental group founded by David Brower. Brower,

who had been the director of the Sierra Club before leaving that organization to found Friends of the Earth, was an advocate of “direct action” in environmental causes. The Rainforest Action Network seized on the Burger King boycott as its primary focus of direct political action. Using mailing lists provided by Brower’s previous contacts, the network organized a base of support through numerous reports and press briefs mailed from its headquarters in San Francisco. The network also provided information on how to organize demonstrations, sold directories listing hundreds of other organizations around the world working on rain-forest issues, and marketed videos for use in elementary schools.

Utilizing its many contacts with local newspapers and television stations, the Rainforest Action Network began to apply political and economic pressure to Burger King to end its practice of importing beef from Costa Rica, Honduras, Brazil, and other Latin American countries. A high point in the campaign was reached on January 22, 1986, when the Rainforest Action Network bought a full-page advertisement in *The New York Times* that asked sympathizers to send letters to Charles Olcott, president of Burger King, at his office in Miami, Florida. Randall Hayes, director of the Rainforest Action Network, later claimed that the advertisement “sent thousands of outraged letters pouring into Burger King’s main office,” although the *San Francisco Chronicle* placed the number of letters in the hundreds. Neither estimate compared to the nearly 2.5 billion customer visits Burger King enjoyed in the United States alone in 1986. Nevertheless, the pressure of frequent adverse publicity was overwhelming. Faced with the possibility of losing a part of its share in the highly competitive U.S. fast-food market, Burger King eventually agreed to end the purchase of beef from many of its earlier sources in Latin America.

According to the Rainforest Action Network, the importation of Latin American beef was promoting the clearing and conversion into cattle pasture of vast areas of tropical rain forest in Central and South America. Representatives of Burger King disputed these claims, as did scientists and government officials in several Latin American countries. Antonio Alvarez, Costa Rica’s minister of agriculture, pointed out that it would be too expensive for most Central American countries to fight an extended war of publicity with environmen-

1985-1987

tal groups in the United States. In Brazil, Guilherme de La Penha, director of the Emilio Goeldi Museum in Belem do Para, an old city at the mouth of the Amazon River, also lamented the financial power of organizations such as the Rainforest Action Network. While acknowledging the serious problems of deforestation in the tropics, de La Penha noted that he would have preferred that environmental groups in the United States spend some of their money in Brazil, where it was desperately needed, rather than on lobbying in Washington.

According to environmental activists, the conversion of tropical rain forests to cattle pastures followed a regular pattern. The first stage was the entry into the rain forest by timber companies seeking to harvest tropical hardwood for the export market. Before this timber could be harvested, roads needed to be built so that loggers could gain access to the forests to fell the trees and remove the logs for transport to local sawmills or to docking facilities for direct export to Europe, Japan, or the United States. Once such roads were in place, the landless poor of the Latin American countries would enter the forests to clear and burn small parcels of lands to grow crops such as corn, rice, manioc, and beans to feed their families. Sometimes



An unspoiled section of Amazon rain forest. (PhotoDisc)

these people would also grow cash crops for sale, such as coffee, bananas, chili peppers, and cacao, which is used to make chocolate.

Such forms of agriculture had been practiced by the Indians of Central and South America for millennia. With so much experience behind them, the Indians could grow food, fiber, and medicinal crops for five or ten years without damaging the soil before they abandoned the cleared areas to permit the forest to reclaim the land and restore the soil's fertility. Unlike the region's Indians, however, most of the people who squatted on the land to grow crops following the building of logging roads had little or no experience with this type of slash-and-burn cultivation. For the first year or two, their crops produced satisfactory yields, but soon the hot, humid climate leached the soil of its nutrients, erosion led to soil loss, and insect pests and the encroaching forest made their meager harvests barely worth the effort.

At that point, the farmers, if they were lucky, would sell the land to speculators seeking to consolidate several such small parcels into a single larger holding for the exclusive purpose of raising cattle for the export beef market. Like the farming families who had first cleared the forest, these ranchers quickly encountered a declining return from their efforts. In most of tropical Latin America, two or three acres of newly cleared rain forest are needed to raise one steer for beef; after five to ten years in grass pasture, however, ten to twenty acres of that same soil is necessary to support one steer. By the time soil productivity had fallen to such a level, most ranchers, like the slash-and-burn farmers before them, abandoned the land to the aggressively invading woody vegetation.

The combined result of large and growing numbers of poor, landless people in Central and South America and the need for nations in that part of the world to earn hard currency from the sale of beef, timber, and other commodities was undeniable. Since the mid-1940's, the clearing and burning of tropical rain forest had plainly accelerated—and, in the process, the niches and habitats of many species of plants and animals had been lost.

SIGNIFICANCE

The impact of the Rainforest Action Network's boycott of Burger King proved much greater in the realm of domestic social psychology

and politics than in the area of tropical rain-forest conservation. Despite Burger King's agreement in 1987 to cease its purchase of rain-forest beef, deforestation did not slow in Central America. Beef that those countries had earlier sold to the United States began to be sold to customers in Europe and East Asia. The rate of conversion of rain forest to cattle pasture dropped by more than 40 percent in Brazil, but the cause was a combination of greater-than-normal rainfall and the end of government subsidies for such conversion.

Burger King's business felt little impact from the boycott. The price of its hamburgers possibly increased a few pennies as a result of its exclusion of the leaner tropical beef, but even that effect is not certain. Moreover, during the late 1980's and early 1990's, Burger King, like many of its competitors, expanded its chain of restaurants beyond the United States at a rapid pace, especially in Brazil, Mexico, Costa Rica, and other Latin American countries where such beef is produced.

After its success with Burger King, the Rainforest Action Network turned its attention to other rain-forest issues. The organization called for boycotts of Mitsubishi and other Japanese corporations and staged demonstrations against the World Bank to protest their roles in deforestation in Brazil and Southeast Asia, but met with only mixed success. Although the World Bank delayed, but ultimately furnished, loans needed to support Brazil's construction of the Trans-Amazon Highway, Japanese corporations involved in the construction all but ignored the protests.

The impact of the Burger King boycott on American social psychology and politics was much more definite. The Rainforest Action Network's bulk-mailed alerts, sheets, and press briefs, along with paid advertisements in newspapers and magazines, sowed the idea in many American minds that the world's tropical rain forests were in imminent danger of disappearance. According to this literature, with "50,000 acres a day" of tropical rain forests being lost, "the last traces of original, irreplaceable paradise will vanish in a single human life span" to be "replaced by desert." Although such claims apparently contributed to the success of the Burger King boycott, they were not well supported by the facts. According to 1980's data from the World Resources Institute, the world's closed tropical forest covered almost four million square miles, or 2.5 billion acres of the earth's surface. A

simple calculation reveals that more than 135 years—certainly more than a single human life span—would be needed at the then-current rates of deforestation to eliminate the world's rain forests.

Moreover, the claim that tropical rain forests are being replaced by desert would come as a surprise to both farmers and ranchers in Latin America. Those who argue against such claims point to examples of renewed rain-forest areas such as the Monteverde Cloud Forest Reserve in Costa Rica. This popular tourist and educational destination allows visitors to see the impressive biological diversity of a tropical rain forest. Much of this habitat for jaguars, quetzals, orchids, and other species indicative of a healthy rain-forest ecosystem was itself in cattle pasture as recently as 1965. In addition, as some observers have noted, although deforestation reduces biological diversity in the short term, extinction is the mechanism that nature uses to open niches for continued evolution of plants and animals as well as of ecosystems such as tropical rain forests.

Despite their continued efforts, environmental groups that work to preserve tropical rain forests have met with firm resistance in some quarters. During the 1992 Earth Summit in Rio de Janeiro, Brazil, for example, although the participating nations reached general agreements on a broad array of issues, those nations of the developing world with tropical rain forests refused to discuss the question of deforestation. From their point of view, the disposition of those forest resources is a matter of domestic sovereignty, and these nations strongly resent efforts to infringe on that sovereignty, whether those efforts are mounted by foreign governments or by foreign environmental groups such as the Rainforest Action Network.

Paul Chandler

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■ **DECEMBER 23, 1985**

U.S. CONGRESS REVAMPS FARM POLICY

Through the Food Security Act of 1985, the U.S. government instituted conservation measures designed to reduce soil erosion, prevent an overabundance of grain crops, and protect wetlands.

ALSO KNOWN AS: Food Security Act; Farm Act of 1985

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Ecology and environment; Government policy and regulation; Land and land policy

KEY FIGURES

Jesse Helms (1921-2008), chairman of the Senate Agriculture, Nutrition, and Forestry Committee

Edward Zorinsky (1928-1987), ranking minority member of the Senate Agriculture, Nutrition, and Forestry Committee

Eligio de la Garza II (b. 1927), chairman of the House Committee on Agriculture

Edward R. Madigan (1936-1994), ranking minority member of the House Committee on Agriculture

Ed Jones (1912-1999), chairman of the House subcommittee responsible for conservation legislation

SUMMARY OF EVENT

The Food Security Act (FSA) of 1985 created the largest change in farm-subsidy programs since the middle of the twentieth century. Prior to the act, the U.S. Department of Agriculture (USDA) estimated that 3.1 billion tons of soil were eroding annually on approximately 420 million acres of cropland, and 3.7 million acres of land were being converted annually from pasture and wetlands, such as tidal flats and swamps, to cropland. Under the FSA, agricultural producers could be denied farm benefits for implementing improper land-use practices on cropland and noncropland. The objectives of the law were to reduce the increasing problems of sedimentation and water and wind erosion, to enhance water quality and habitat for fish and wildlife populations, to protect the long-term ability to produce



Natural wetland near the headwaters of the Missouri River. (©Photoboykane/Dreamstime.com)

food and fiber resources, to reduce the supply of grain crops, and to provide income to farmers.

The “Swampbuster” provision of the FSA was intended to discourage the conversion of wetlands to agricultural land. This provision was considered an essential component of the legislation, as more than one-half of the wetlands that existed when the United States was first settled had been eliminated by the mid-1980’s. Protecting wetlands would have significant implications for controlling floodwaters and providing recreational opportunities. Under the Swampbuster provision, farmers who produced agricultural crops on wetlands converted after December 23, 1985, would be ineligible for farm benefits, including commodity loans and purchases, subsidies, and crop insurance. In addition, benefits would be lost not only on converted land but also on all lands farmers wanted to enroll into the program.

The “Sodbuster” provision of the FSA was similar to the Swampbuster provision but focused on the conversion of highly erodible land to agricultural production. This provision applied to highly erodible land that was not planted with annually tilled crops during the period between 1981 and 1985. For land to be considered highly

erodible, potential erosion had to be estimated at more than eight times the rate at which soil could maintain continued productivity. Farmers who produced commodities on previously uncultivated land with highly erodible soils after December 23, 1985, were ineligible for federal farm programs unless the owner farmed under a conservation plan approved by the local soil and water conservation district. Natural-resource managers estimated that implementing the Sodbuster and Swampbuster programs would prevent the conversion of more than 225 million acres of grasslands, forests, and wetlands to croplands.

The "Conservation Compliance" provision was developed to discourage the production of crops on highly erodible cropland where land was not protected from erosion. Under this provision, if landowners produced crops on fields with highly erodible soils without an approved conservation plan, they could lose their eligibility for specific USDA benefits. Conservation Compliance applied to land where annually tilled crops were grown at least once between 1981 and 1985; the provision was to apply to all highly erodible land in annual crop production by 1990.

The Agricultural Stabilization and Conservation Service (ASCS) administered the Conservation Reserve Program (CRP) provided for in the FSA with the intention of converting up to 45 million acres of highly erodible farmland to permanent cover. Federal officials hoped that this program would reduce soil erosion by 760 million tons, stream sedimentation by in excess of 200 million tons, pesticide use by 61 million pounds, and fertilizer use by approximately 1.4 million tons annually. Specific objectives of the CRP were to assist in controlling soil erosion, reduce surplus crop production, improve water quality, and provide wildlife habitat.

Under the CRP, landowners would submit bids through the ASCS to establish ten-year contracts with the USDA. While under contract, landowners received annual rental payments for converting highly erodible cropland to permanent vegetative cover for the duration of the contracts. Participants in the program were required to establish permanent vegetative cover (grasses, legumes, forest plantations, field windbreaks, shallow-water areas, or a combination of these practices) as quickly as possible. Approximately one-half the cost was shared by the USDA. In some states, additional funds were available

to farmers for developing selected permanent cover on CRP lands for wildlife species.

SIGNIFICANCE

By implementing the conservation provisions of the 1985 FSA, the USDA was able to provide economic benefits to landowners and to conserve natural resources on agricultural lands. These programs would produce large-scale changes in the composition of agricultural landscapes in the United States by the early 1990's.

In the first year under the 1985 FSA, from March, 1986, through the fourth sign-up in February, 1987, nearly eighteen million acres were enrolled in the CRP alone. One year later, more than 25 million acres had been enrolled.

Henry Campa III

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■ FEBRUARY 4, 1989

SOVIET FARMERS GAIN CONTROL OF LAND AND CROP SELECTION

Farmers in the Soviet Union were under tight state supervision until Communist Party general secretary Mikhail Gorbachev's program of perestroika brought about a loosening of the government controls.

LOCALE: Estonia, Soviet Union

AGRICULTURAL ISSUES: Agrarian reform; Collectivization; Government policy and regulation; Land and land policy

KEY FIGURES

Mikhail Gorbachev (b. 1931), general secretary of the Communist Party of the Soviet Union, 1985-1991

Boris Yeltsin (1931-2007), president of the Russian Soviet Federated Socialist Republic, 1991-1999

Aleksandr Nikonov (b. 1918), agricultural specialist and a primary theorist of agrarian perestroika

Vladimir Tikhonov (b. 1927), primary publicist for agrarian reform in the Soviet Union

SUMMARY OF EVENT

On February 4, 1989, three Estonian farmers became the first citizens of the Soviet Union to receive formal documents from the government allowing them to use land permanently and without charge for independent farming. This event represented the culmination of a fairly long and involved movement in official Soviet thinking away from an emphasis on large state and collective farms and toward an emphasis on the individual, independent peasant farmer. As such, it marked a watershed in Soviet agricultural theory and practice.

With the coming of the Bolshevik Revolution in 1917, Soviet agriculture was in dire straits. Production of food had plummeted as a result of enormous casualties of men and draft animals in World War I and widespread rural unrest in connection with the "agrarian revolution" of peasants against their landlords. Upon their accession to

power, the Bolsheviks immediately issued a decree titled "On Land" on November 8, 1917, followed up by the more comprehensive "Decree Concerning the Socialization of Land" on February 19, 1918, whereby all landlord property rights were abolished and estates confiscated. In addition, all land was nationalized and was to be parceled out to local collectives, or soviets, for distribution to those who tilled it. Preference was to be given to collective farms, but the primary purpose of the legislation was to ensure the equitable distribution of land among individual peasant farmers and thereby gain them as allies of the proletariat (under the guidance, of course, of the Bolsheviks).

This alliance, however, was not to be permanent; rather, it was to serve as a temporary arrangement whereby the urban proletariat, which was the mainstay of the new Bolshevik state, could be assured of sufficient food. Bolshevik leader Vladimir Ilich Lenin saw the eventual outcome as the creation of a second revolution in the countryside that would set the farm laborers and poor peasantry against the more well-to-do farmers (or kulaks, as they came to be called).

Under the policy known as War Communism (1918-1921), the Bolsheviks came to rely more and more on forced seizures of grain and other products from the peasantry in order to ensure a minimal flow of foodstuffs to the cities. State compulsion became the order of the day, in the form of acreage goals, mandatory improvements of farming techniques, forced labor drafts, a national plan for sowing different crops, and increasing pressure on the approximately fifteen million small peasant households to join collective and state farms. As a result, by the spring of 1921, agricultural production had fallen to disastrously low levels.

Lenin's solution, in the form of the New Economic Policy (NEP), was to grant the peasantry titles in perpetuity to land that they cultivated and to restore ownership of personal property, primarily draft animals and farming implements, that had been confiscated. Although actual land ownership remained with the state, the peasants were free to choose which type of land tenure they preferred (individual, cooperative, or collective) and had the right to select which crops they wished to grow and how they chose to cultivate them. These rights were codified in the Law of Toilers' Land Tenure (also known as the Land Code) of May 22, 1922.

The Land Code constituted the high-water mark in terms of individual freedom for the peasantry for almost the next seventy years. Lenin's successor as head of party and government, Joseph Stalin, in pursuit of his goal of "socialism in one country," embarked on a crash program of industrialization of the Soviet Union. This industrialization was to be financed largely by enhanced earnings generated by an increasingly rational and productive agricultural sector. Stalin and his supporters believed that the individual and small cooperative peasant holdings were both ideologically undesirable and economically backward; they believed that Soviet agriculture could be brought into the twentieth century only if such holdings were consolidated into large collective and state farms.

The ensuing period of forced collectivization, the "liquidation of the kulaks," was aimed ostensibly at the elimination of the remaining rural landlords. In actuality, the "middle peasantry," or individual peasant proprietors who worked their own land, were denounced as kulaks and forced into large collective and state farms. Those who resisted were either killed outright or exiled for long terms to Siberia.

Because the middle peasantry formed the backbone of Soviet agriculture, the destruction of this group had disastrous immediate and long-term results. Even Stalin realized that something had to be done, and in 1933 he denounced local leaders for forcing the pace of collectivization—which they had done only at his insistence—and threw the peasants a sop in the form of individual plots and livestock. This meant that even though all peasants lived and worked on either collective or state farms, they were given very small plots of ground that they could cultivate in their free time and were also accorded the right to own small amounts of livestock, usually a cow and a few chickens.

This situation in terms of individual peasant rights existed relatively unchanged over the next fifty years. Under Stalin's successor, Nikita S. Khrushchev, an attempt was made to consolidate smaller collective and state farms and to curtail the size of individual plots, but the resulting difficulties contributed to Khrushchev's ouster from power in 1964. Soviet agriculture under Leonid Brezhnev and the short-lived regimes of his successors, Yuri Andropov and Konstantin Chernenko, was marked by enormous investments of re-

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sources in an increasingly inefficient system of state and collective farms. In this system, individually cultivated plots and individually owned livestock, although they constituted only a minuscule proportion of total cultivated land and livestock in the Soviet Union, produced an embarrassingly high percentage of the milk, eggs, and vegetables consumed in the country.

When Mikhail Gorbachev took the reins of power in 1985, the overall Soviet economy (including agriculture) had deteriorated to an almost unbearable level of stagnation and inefficiency. Gorbachev's answer to these problems involved a basic restructuring, or perestroika, of the economic system. An integral part of perestroika consisted of a series of basic changes in the agrarian sector, changes that were based largely on the ideas of Aleksandr Nikonov, an administrator, agricultural specialist, and close personal friend



Soviet leader Mikhail Gorbachev (right) talking with farm equipment workers in the Ramensky District, near Moscow, in August, 1987. (AP/Wide World Photos)

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and adviser to Gorbachev, and Vladimir Tikhonov, a well-known public figure and popularizer of agrarian perestroika. The primary ideological impetus for the Nikonov-Tikhonov reforms lay in the alienation of the peasantry from the land, an alienation born of forced collectivization and nourished by the continuing lack of any meaningful individual control over the land.

In a more instrumental vein, Nikonov also alleged that the large collective or state farm was not necessarily the optimal size for modern production; he pointed to smaller, family-based units in the United States as a more economically efficient mode of production. The reasoning was that if a level playing field could be created whereby individual and small cooperative farms could legally compete on an equal basis with state and collective farms, Soviet agriculture would benefit greatly. This approach was embodied in a March, 1988, resolution by the Estonian Council of Ministers and Communist Party Central Committee titled "On Individual Labor Activity in Agriculture." Pursuant to this policy, on February 4, 1989, three Estonian peasant farmers (the first of more than one hundred) were granted title to their land.

SIGNIFICANCE

In terms of potential impact, granting life tenure and free usage of land to the three Estonian farmers opened up a whole new theoretical and practical vista in Soviet agriculture. Immediate consequences of the change were somewhat limited in scope, however.

In an immediately practical sense, Gorbachev's agrarian perestroika bore a remarkable resemblance to the agricultural component of Lenin's NEP. Both granted the peasant farmers life tenure and limited inheritance, free choice of crops and methods of cultivation, and free choice of the mode of production—individual, cooperative, or collective—within which they desired to live and work. There was, however, an important theoretical distinction between the two policies. Lenin's NEP was designed to be a temporary measure to sate the desire for land on the part of the peasantry; eventually, through education in the principles of socialism and by the example of the more efficient operation of collective and state farms, peasants would be weaned from these petit bourgeois proclivities. In contrast, Gorbachev's agrarian perestroika was seen as a permanent method for

alleviating the alienation of the peasantry from the land and for enhancing the productivity of Soviet agriculture. Indeed, Boris Yeltsin, president of the Russian Soviet Federated Socialist Republic (RSFSR), stated that the peasant owner was the foundation for agrarian development.

The need for formal legislation to give individual farms legal status and protection was met by the Soviet Law on Property (passed on March 6, 1990, and based on the Principles of Land Legislation); the RSFSR Congress Resolution on Private Ownership of the Land of December 4, 1990; and the Soviet Presidential Land Reform Decree of January 7, 1991. These documents formally allowed private ownership of land, right of inheritance, free access to land, and freedom to choose forms of farming. Critics, however, pointed out that these laws were largely a dead letter, because managers of collective and state farms and other figures in the local agrarian apparatus dominated local legislative and administrative levels and could be expected to scuttle the actual operation of the program. Indeed, as of February 1, 1991, the newspaper *Izvestia* reported that in the RSFSR there were thirty-five hundred peasant farms and four thousand small agricultural cooperatives involving a total of some fifty thousand people, a minuscule proportion of the total persons employed in the Russian agricultural sector.

The situation was paradoxical. There was a strong push from the top for the growth of individual peasant and small cooperative agricultural enterprises, but the response at the grassroots level was lukewarm. This tepid response was based on at least two factors. The peasants, having been encouraged under Lenin to work hard on their own land and then denounced as kulaks under Stalin and forced onto collective and state farms, had no desire to be burned again. Perhaps even more important, Stalin's forced collectivization, whereby the successful middle peasants were liquidated, resulted in the destruction of the very type of people who could make agrarian perestroika work. The remaining peasantry, with a few shining exceptions, were largely content to continue their existence as cogs in a machine of institutionalized dependence. It would take time and greater trust in government intentions to overcome these ingrained attitudes.

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FURTHER READING

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■ MARCH 13-APRIL 15, 1989

UNITED STATES BANS CHILEAN FRUIT AFTER CYANIDE SCARE

By impounding Chilean fruit at ports in reaction to the discovery of two poisoned imported grapes, the U.S. Food and Drug Administration disrupted the domestic produce market and the Chilean fruit industry.

LOCALE: Washington, D.C.

AGRICULTURAL ISSUES: Chemistry; Disease and health issues; Government policy and regulation; Marketing and trade; Pests and pesticides

KEY FIGURES

James Baker (b. 1930), U.S. secretary of state, 1989-1992

Frank E. Young (b. 1931), commissioner of the U.S. Food and Drug Administration, 1984-1989

Hernán Felipe Errázuriz (b. 1945), foreign minister of Chile

SUMMARY OF EVENT

Thousands of tons of fruit from Chile were withdrawn from the shelves of supermarkets after an inspection at the port of Philadelphia in 1989 found two grapes that had been poisoned with cyanide. The U.S. Food and Drug Administration (FDA) immediately launched an investigation and started to impound all fresh fruit arriving from Chile. In an announcement made on March 13, 1989, the FDA advised consumers to discard any fruit if they were not sure that it came from somewhere other than Chile.

FDA commissioner Frank E. Young thought it better to be overly cautious than not cautious enough, and he took the view that it was best for the public to know of any danger. He also stated that there was no need to panic. The poison had been found in just two grapes unloaded in Philadelphia, and no reports of death or sickness from eating fruit had been received. Nevertheless, the FDA's advice to discard fruit and the impounding applied to all fruit from Chile, not only grapes.

Estimates from the American Produce Association, which represented sixty-five importers of produce from Chile, indicated that the removal of suspect Chilean fruit from markets involved two million cases. At that time of year, Chile was a principal supplier of fresh fruit to the United States, with shipments including large quantities of peaches, nectarines, soft fruits, melons, and Granny Smith apples as well as grapes.

Scientific analysis could not reveal how much poison was originally inserted into the two grapes. The amount of cyanide detected in them once they had reached Philadelphia was tiny, not even enough to cause illness in a small child. The two contaminated grapes were in a sample of more than two thousand bunches checked. Even two contaminations in a sample indicated deliberate tampering, but the case could still have been an isolated one.

The FDA's action was prompted by more than the scientific evidence. Some special inspections of fruit from Chile had been ordered a few days before the discovery of the contaminated grapes, after anonymous telephone warnings were received in Santiago, Chile. The embassies of both the United States and Japan in Chile had received calls on March 2 from a person stating that fruit bound for the United States from Chile had been poisoned as a protest against unspecified policies of Chilean president Augusto Pinochet Ugarte. The FDA responded with extra inspections at ports of entry. After finding no contamination, the agency issued a statement saying that the calls had been a hoax. The statement was published in Washington, D.C., and Santiago. A caller to the U.S. embassy on March 9 then responded that there had been no hoax, and further intensive inspections uncovered the two tainted grapes.

As tons of grapes were removed from supermarket shelves, some people wondered whether the FDA had overreacted. In California, an importer ate grapes at a news conference to publicize that viewpoint. Only 0.003 milligrams of cyanide had been detected in each of the two tainted grapes. It would take twenty-five milligrams of cyanide to make an adult sick; 200 milligrams constitutes a lethal dose. It was troubling, however, that the anonymous caller had correctly warned that the poison would be injected into the fruit. This meant, first, that washing the fruit would not eliminate the threat and, second, that any poisoning of hard-skinned fruit, such as cantaloupes or apples,

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would be harder to detect by inspection than had been the tampering with grapes.

The inspection team assembled by the FDA, including staff from the U.S. Department of Agriculture, numbered several hundred. Inspectors descended on ports of entry, including Philadelphia, New York, Miami, and Los Angeles, effectively putting all Chilean produce in quarantine. Some 65 percent of the goods entered at Philadelphia. The contaminated grapes had been unloaded from the *Almeria Star*, which was still in dock on March 15. Three more freighters were due to arrive with about 1.5 million cases of produce. In the spring season, about half a million cases of produce per day were expected to arrive in the United States from Chile.

The first four days of what was effectively an embargo against Chilean produce cost as much as \$100 million, at wholesale prices, in lost business. The greatest impact was felt by growers and packers in Chile. Importers, distributors, and retailers in the United States also suffered losses. Good estimates of the damage were difficult to make because the insurance position was unclear in the absence of a legally mandated recall and because in the fruit and vegetable trade many deals are conducted on handshakes, without written contracts.

In Chile, some official statements were critical of the FDA action, but the Chilean government moved swiftly to work with the United States on a solution to the crisis. On March 15, Foreign Minister Hernán Felipe Errázuriz arrived in Washington for urgent talks with U.S. government officials. Chile's food export industry was worth \$700 million per year, second in importance only to copper as a means of earning foreign exchange, and was very reliant on trade with the United States. It was in immediate danger of being brought to a standstill. Exports of fruit to Japan and Canada also had been affected.

The Exporters' Association in Chile had already decided to submit all fruit voluntarily to government inspection before shipment. This halted the movement of goods out of Valparaíso, the main port. Trucks loaded with fruit deliveries to the port were halted, and, back on the farms, pickers were sent home. The whole industry was paralyzed by March 16, which was about halfway through the season. Some 47 million crates of fruit had been shipped so far out of what, before the crisis, was expected to be 103 million.

Meanwhile, hundreds of inspectors in the United States had found

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no poisoned produce beyond the original two grapes. As the inspections continued, a joint statement was issued in Washington by Foreign Minister Errázuriz and Secretary of State James Baker. The statement, issued on March 16, said that the two parties had agreed to work together to deal with the crisis. A team of American inspectors was sent to Chile to review the security procedures of farmers and exporters.

Just one day later, on March 17, FDA commissioner Young announced that Chilean fruit would be returning to American grocery stores. Inspectors would check 5 percent of incoming grapes and berries instead of the previous 1 percent. No decision had yet been made on hard fruits. Shopkeepers were advised to check each batch received. State governments were asked to supervise the destruction of fruit that already had been delivered to distributors and retailers. Errázuriz, speaking from the White House, said that Chile welcomed these developments.

After four days, the 5 percent inspection was extended to nectarines, peaches, and plums; melons were still excluded from importa-



A Valle del Elqui vineyard in central Chile. With a climate similar to that of California in the Northern Hemisphere, Chile produces many agricultural products familiar to North Americans. Because its seasons are opposite those of North America, it can supply fresh produce to the United States that is out of season there. (©Uros Ravbar / Dreamstime.com)

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tion. Meanwhile, the first grapes released from inspection at Philadelphia arrived in markets on March 23. Reports indicated that customers had little hesitation about buying them.

On April 15, 1989, the FDA announced the end of all restrictions and special measures applying to Chilean fruit. No poisoned produce had been detected except for the two grapes found on March 12. Inspections would revert to the 1 percent check; things were back to normal.

SIGNIFICANCE

The crisis over fruit from Chile lasted only a month, and the embargo itself was in place for only eleven days, but the immediate impacts of these events were severe, with effects felt not only in Chile and the United States but also in other countries. The long-term impacts, in contrast, were small, as normalcy resumed after the emergency and no new regulations on food were proposed as a result of it.

In Chile, the effects of the crisis were instant and drastic. In that country, 5 percent of the population is employed in farming, which is a billion-dollar-a-year industry. The fruit-growing business had been in a stage of dynamic growth when the interruption occurred. Exports to the United States in 1988-1989 were expected to be 16 percent higher than in the previous year and 40 percent higher than during the 1984-1985 season. Chile's climate was ideal for this kind of crop, and the seasons were the opposite of those in the United States, making a good complementary fit. Chile could provide certain kinds of produce exactly when they were out of season in the United States. The U.S. market was the largest destination for Chilean fruit, so the embargo was a catastrophe for Chile. Twenty thousand Chileans were out of work within two weeks of the poison scare, and commercial losses were estimated at \$200 million or more.

Effects were also immediate elsewhere. In Canada and Japan, health officials warned against eating fruit from Chile, effectively stopping its sale. In Hong Kong, inspectors seized imports from Chile and stopped the sale of grapes. In the European Community, the response was more restrained, and only in Denmark were Chilean imports taken from the shelves of stores.

In the United States, one effect of the poisoned grapes, aside from the impacts on the market described above, was a reinforced concern

for food safety generally. In late March, 1989, both *Time* and *Newsweek* had cover stories on food safety that captured the public's mood. Building on existing concern about the use of alar on apples, the grape scare prompted discussion of a whole variety of risks from food, including environmental contaminants, pesticide residues, additives, and foodborne disease.

A related issue that also was discussed in earnest at this time was the weighing of risks against costs. This discussion spilled over to other areas, including new drugs, airline safety, and terrorism. The balancing of risks between openness and secrecy when anonymous threats are made, between the needs of patients and the dangers of untried drugs, and between risks from contamination and costs of inspection were among the issues discussed. Some commentators argued that an immediate threat, such as poisoned food, requires a response perhaps erring on the side of caution, whereas threats such as carcinogens, which have distant and uncertain effects, are a different matter. The airing of these considerations about the different kinds of risks promoted public interest and awareness but did not lead to any changes in FDA procedures.

A curious postscript occurred more than three years after the Chilean grape incident. Late in 1992, Chilean fruit growers filed a lawsuit claiming \$330 million in damages from the U.S. government for the effects of the embargo of March, 1989. There had been, it seems, irregularities in the testing procedures used at the FDA. The laboratory in Philadelphia destroyed the tested grapes, contrary to FDA regulations, according to an article by Herbert Burkholz in *The New Republic*. Other grapes from the sample showed no signs of cyanide poisoning, even though cyanide is a migratory substance that probably would have spread to other grapes if the poison had been injected days earlier in Chile or on the ship in transit. Cyanide is used in laboratories to calibrate instruments and to spike samples to guard against false negative results. It is therefore possible that the contaminated grapes were injected with cyanide by the FDA itself.

Richard Barrett

FURTHER READING

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■ OCTOBER, 1990

AFRICANIZED BEES THREATEN U.S. AGRICULTURE

The arrival of Africanized honeybees threatened agriculture, tourism, and the honey industry in the United States.

LOCALE: Brazil; Southern United States

AGRICULTURAL ISSUES: Ecology and environment; Genetic engineering; Pests and pesticides

KEY FIGURES

Warwick Estevam Kerr (b. 1922), Brazilian geneticist who introduced the African honeybee to South America

Mark L. Winston (b. 1950), research professor at Simon Fraser University who studied Africanized bees in both North and South America

Thomas E. Rinderer (fl. late twentieth century), insect geneticist at the Honey Bee Breeding, Genetics, and Physiology Laboratory in Baton Rouge, Louisiana

SUMMARY OF EVENT

Honeybees originated in tropical regions of Asia and then migrated throughout Europe and into Africa, where they developed a more aggressive nature in response to the threats posed by army ants, honey badgers, anteaters, giant toads, and human beings. Early European settlers brought the first honeybees to the Western Hemisphere, carrying the relatively docile European variety into the interior, where the bees quickly became an important part of the agricultural economy.

From the early 1980's, scientists, agriculturists, and a curious public followed the progress of migrating swarms of "killer bees" that had terrorized much of Latin America for almost thirty years and were then approaching the United States. In October, 1990, these Africanized bees crossed the Mexican border into southern Texas near Hidalgo. That event significantly affected the lives and jobs of

To the casual observer, this Africanized honeybee looks like any ordinary European bee. The most visible difference is that it has slightly smaller wings. (USDA)



many Americans. In 1993, the first death in the United States attributed to stings of Africanized bees was reported, raising fears among Americans about the potential danger posed by the bees.

During the mid-1950's, the Brazilian government called on geneticist Warwick Estevam Kerr to develop a bee that would be well suited to Brazil's Amazonian climate. Reports of outstanding honey production in southern Africa convinced Kerr to go there for his breeding stock. He knew that African honeybees are aggressive, but he believed that crossbreeding them with indigenous South American stock would produce a gentler bee capable of greater honey production. In Africa, Kerr collected 173 African queen honeybees, less than one-third of which survived the trip back to Brazil. Of those that remained, he chose thirty-five to use in his breeding program. Headed by African queens, his colonies became some of the most productive ever seen. In 1957, a careless beekeeper allowed twenty-six of the thirty-five colonies to escape into the surrounding forest. There is some evidence to suggest that more Africanized queens were reared from the remaining colonies and distributed to Brazilian beekeepers, hastening the rapid spread of Africanized bees.

After 1957, swarms of Africanized honeybees spread at an alarming rate. By 2005, substantial numbers of counties in seven U.S. states (California, Nevada, Arizona, New Mexico, Texas, Oklahoma, and Florida) had reported the presence of Africanized bees, and a few counties in Arkansas and Louisiana had also observed their pres-

ence. The bees moved two hundred to three hundred miles each year, migrating through a process known as swarming. When swarming, worker bees first gorge on honey to fuel themselves while the new nest is being established. Next, they go into a frenzy, chasing, biting, and pulling their queen until she is forced out of the nest. Workers and queen then orient themselves to each other by secreting highly attractive chemicals. Finally, scout bees lead the cluster to a new nesting site.

Africanized bees swarm more often, and thus spread more rapidly, than European bees for two principal reasons. European honeybees normally construct large nests and store more honey; this provides them with greater resources but takes up much of the hive's energy. Africanized honeybees build smaller nests and store less honey, reserving more energy to swarm. Africanized bees also tend to swarm at an earlier age. In Africa, this instinct compensates for colonies lost to predators. In Latin America, however, where the bees have fewer natural enemies, colonies proliferate. It was estimated in 1992 that there were one trillion Africanized honeybees in 50 million to 100 million nests throughout the Western Hemisphere.

These estimates, like others required for study, were necessarily difficult to arrive at because there is little physical difference between Africanized and European honeybees. The threat of further migration and its attendant dangers, however, made accurate identification imperative. As a result, Thomas E. Rinderer, an insect geneticist, and his colleagues at the Honey Bee Breeding, Genetics, and Physiology Laboratory in Baton Rouge, Louisiana, developed the Fast African Bee Identification System, which involves measuring bees' wings. The wings of the European honeybees are minutely larger than those of the Africanized bee. Another means of identification, developed around 1990 by entomologist Akey C. Hung, involves the identification of two proteins that are distinct to Africanized honeybees.

Scientists knew that European and Africanized honeybees would meet in a struggle for territory. Because Africanized bees are usually aggressive, they typically win the contest for territory. Sometimes Africanized drones—male bees that live only to mate with new queens—mate with European queens, which lay more Africanized eggs, eventually leading to the conversion of the colony. When

swarming, Africanized bees sometimes simply fly in and colonize European hives. At times, when territories overlap, the species interbreed. In these transitional zones, scientists have found gentle Africanized bees and aggressive European bees, although usually the crossbred bees exhibit aggressive traits.

The contest for territory is directly related to the bees' need for flowers from which pollen and nectar are gathered. Nectar, rich in sugars, is the energy source for the hive and is used to make honey. Pollen, which contains proteins, fats, minerals, and vitamins, is used for the growth of larvae and the maintenance of the adults. After pollen is collected, it is moistened with honey, then pressed into compact pellets and stored in special cells inside the nest. Africanized honeybees often fly miles out of their way to locate new sources of flowers for forage, thus challenging their European relatives, which remain in more confined areas.

Many tactics were developed to stop the Africanized honeybees' invasion of the United States. A commission was established in Panama to intercept colonies being transported by ships passing through the Panama Canal. Reports of Africanized bees arriving in California by truck led to the establishment of a quarantine along roads leading out of Mexico. Areas reporting hostile bee activity were flooded with European bees. Traps baited with highly attractive substances (pheromones) were strategically placed in Mexico and the southern United States.

By late 1987, the United States and Mexico had jointly funded and implemented the Bee Regulated Zone, an effort to enforce a biological barrier at the Isthmus of Tehuantepec in southern Mexico. Although this comprehensive plan included quarantines, colony destruction, drone flooding, traps, and educational programs, it had virtually no effect on the advance of Africanized colonies toward the United States. The most effective means of protecting European colonies remained the localized marking of queen bees with acrylic paint, with monthly monitoring to ensure that colonies had not been contaminated. With the failure of international initiatives, American agriculturalists and researchers determined that the Africanized bee had become a permanent part of the natural environment and thus began to focus attention on how to cope with this new member of the insect community.

SIGNIFICANCE

The United States faces many of the same problems caused by killer bees in Latin America since 1957. First, the threat to humans is significant. The sting of the Africanized honeybee is essentially the same as that of other bees, but the Africanized bees attack in greater numbers, giving off an alarm odor that immediately attracts hundreds more bees to the tagged victim. People who have disturbed Africanized hives have been attacked and followed for more than a mile, and dozens of people have been killed. One of the worst incidents occurred in 1986 in Costa Rica, when Inn Siang Ooi, a botany student from Miami University, died as the result of receiving more than eight thousand stings.

The first death caused by Africanized bees in the United States was reported in 1993, and attacks became more frequent thereafter. On one occasion, four Americans who were hunting near the Texas-Mexico border shot into a rattlesnake hole. Africanized bees immediately attacked David Reddick, who received more than six hundred stings. One of Reddick's friends observed that "he'd pull a handful off his face and they'd be replaced immediately." Such occurrences created a threat to tourism throughout the South, most notably in Texas, which relies heavily on tourism as a source of revenue.

In order to gauge the threat to humans more accurately, Mark L. Winston studied the behavior of Africanized bees in Suriname. Dressed in a veil, heavy gloves, and two layers of clothes under heavy bee overalls, Winston and an apiary owner approached the bees' hives from a distance of five hundred yards. Simply walking toward the nests brought a massive response. Even before the two men opened the first hive, bees were stinging through their protective clothing and ferociously slamming into the veils covering their faces. During those few minutes, Winston was stung more than fifty times. Events such as this drove many South American beekeepers away from the business, leading to the collapse of the region's honey industry.

The presence of the Africanized bees has also posed a threat to agriculture in the United States. As much as one-third of American food crops rely on annual pollination by honeybees. Apples, berries, cantaloupes, cucumbers, almonds, and melons all require the deliberate transport of more than two million colonies each year. Fear of

the Africanized honeybee has the potential to result in huge financial losses to both farmers and beekeepers, which would in turn burden consumers with higher prices.

The presence of Africanized bees also threatens the American beekeeping industry, particularly those beekeepers who rent colonies for the pollination of crops. Almost every acre of crops requires one or two colonies, with up to six in the case of alfalfa seeds; some farmers require four thousand colonies at a time for pollination. Beekeepers, who are paid a set amount for each colony they provide, were badly hurt financially by a quarantine against bee transport that was imposed in parts of Texas to prevent the further spread of Africanized bees.

This quarantine also affected Canadian agriculture. Instead of transporting queens from the south, Canadian beekeepers changed their requeening season to late spring or early summer in order to produce their own. They also started insulating hives and keeping colonies indoors in order to avoid transport to the south for winter. To keep Africanized bees out, Canada closed its borders to bee importation from the United States, buying instead from New Zealand and Australia.

In addition, the quarantine made beekeeping itself more expensive. Beekeepers in the northern part of the United States traditionally moved their colonies south during the winter, and southern beekeepers moved their colonies north when pollen and nectar were in short supply. Quarantine and fear of Africanization, however, made these practices impossible, costing beekeepers thousands of dollars in lost bees and feeding costs. Beekeepers also faced additional costs in requeening their hives. With 90 percent of queening areas in the southern United States under quarantine, beekeepers found it necessary to purchase queens from other countries at higher prices.

In addition to farmers, beekeepers, and consumers, American taxpayers in general have paid for the entry of the Africanized honeybee into the United States, as the federal government has spent large sums of money on projects to stop or modify the killer bee. In Mexico, at Puerto Escondido on the Pacific coast and at Huatuxco on the Caribbean coast, traps were set to funnel bees flying under three thousand feet into passes, where they are killed. These two projects

alone cost the United States and Mexico an estimated \$6.3 million. The cost of enforcing quarantines in southern Texas alone during the early 1990's was estimated at more than \$1 million.

Although the impact of the Africanized honeybee's arrival has been substantial, the worst fears of early commentators have not been realized. Having learned that the bees cannot be stopped, or the feral population altered, American agriculturalists have instead focused resources on management of the new arrival. With greater resources, decades of experience, better facilities for education, and a widespread agricultural extension program, the United States should be better able to cope with the problem than were Latin American neighbors. Most scientists agree that Africanized bees are not likely naturally to spread north of the thirty-second parallel because of cold temperatures, and this natural barrier serves to assist human efforts to prevent their spread. Nevertheless, as much as one-third of the United States may eventually be inhabited by these bees, affecting farmers, beekeepers, and consumers throughout the country.

John Powell and John Grady Powell

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■ APRIL-OCTOBER, 1993

MISSISSIPPI AND MISSOURI FLOODING DAMAGES AGRICULTURE

Heavy rains and an unusually high snowmelt caused rivers throughout the Midwest to begin rising in the spring of 1993, and unremitting rainfall throughout the summer led to record flooding on the Missouri and Mississippi rivers, as well as many major tributaries, breaching or overtopping levees and causing major damage to agricultural regions and several urban areas over a six-month period.

LOCALE: Midwestern United States

AGRICULTURAL ISSUES: Flooding; Natural disasters

KEY FIGURES

Bill Clinton (b. 1946), president of the United States, 1993-2001

Mike Espy (b. 1953), U.S. secretary of agriculture, 1993-1994

Mel Carnahan (1934-2000), governor of Missouri, 1993-2000

Jim Edgar (b. 1946), governor of Illinois, 1991-1999

Terry E. Branstad (b. 1946), governor of Iowa, 1983-1999

James Lee Witt (b. 1944), director of the Federal Emergency Management Agency, 1993-2001

SUMMARY OF EVENT

A confluence of weather-related events beginning in the autumn of 1992 initiated a chain reaction that produced one of the greatest natural disasters to befall the United States in the twentieth century. Unusually heavy fall rains followed by considerable winter snowfalls combined to create higher-than-average spring runoff into rivers and streams in the upper Midwest, swelling tributaries that fed into the country's major midwestern rivers, the Missouri and Mississippi. Heavy spring rains throughout the region added to the problem. Unfortunately, although forecasters realized that rivers might rise to higher-than-normal levels, few predicted the magnitude of the floods that would cripple the nation's midsection for nearly six months.

By May, 1993, the Redwood River in Minnesota, the Arkansas

River in Kansas, the Mississippi River, and the Missouri River were at flood stages in several areas. Officials in Kansas City and St. Louis were already expressing concern for the safety of individuals and businesses in those metropolitan areas. Constant rains continued to swell tributary rivers in South Dakota, Wisconsin, Minnesota, and Iowa, and as the crests along these rivers moved downstream, the waters in the Missouri and Mississippi rivers continued to rise. Many communities were forced to mobilize emergency efforts to sandbag levees in an attempt to prevent major flooding. Nevertheless, by June levees were beginning to break, and those living in areas immediately adjacent to the rivers were forced to begin evacuations.

As waters rose throughout the region, the economy began to suffer as well. As water swept downstream, levees were topped or breached, and land became flooded. River traffic was halted as major port cities along the Missouri and Mississippi began to feel the effects of rising water that swamped docks, breached levees, and flooded areas along the rivers' banks. Highways and railways adjacent to the rivers became impassable, and bridges over key waterways were washed out. Crops could not be planted; as a result, costs for staples such as corn and soybeans rose significantly.

Many small towns were completely underwater, and even larger cities had to conduct evacuations. Limited evacuation occurred in St. Louis as well, where the water remained above flood stage for nearly three months. Several cities, including Des Moines, Iowa, were without potable water for weeks. An even more sinister tragedy struck Quincy, Illinois, where someone intentionally damaged the levee along the Mississippi, causing the entire city to become submerged.

The strain on state governments was significant. Governors Jim Edgar of Illinois, Mel Carnahan of Missouri, and Terry E. Branstad of Iowa were forced to call out National Guard troops, mobilize community emergency-preparedness units, and plead with federal officials for emergency assistance. They spent considerable time as well lobbying their own legislatures for funds to provide temporary shelter for those displaced by rising waters and to pay for resources needed by agencies fighting the floods. These governors, as well as those in other states, including Wisconsin, South Dakota, and Minnesota, which also suffered flood damage, were visible presences in the areas



Flooded Iowa farm. (©Laurin Rinder/Dreamstime.com)

most damaged, as were federal officials, who, after some initial reluctance to recognize the seriousness of the problem, eventually mobilized the resources of the U.S. government to assist in combating the disaster.

Among national leaders who responded aggressively to the calamity was President Bill Clinton, whose administration was facing its first major natural disaster. Although initially slow to recognize the severity of the situation, the Clinton administration made the disaster a national priority once it became apparent that the floods would have significant impact on the country's economy. Clinton made several trips to the region, including one on July 4 to give national visibility to the scope of the disaster. In Washington, members of the president's cabinet worked with leaders in the House of Representatives and the Senate to pass legislation providing emergency funding to those whose lives were being disrupted.

Secretary of Agriculture Mike Espy was also a frequent visitor to the affected states and led the federal drive to provide accurate estimates regarding damages to the annual harvest in the region typically thought of as the breadbasket of America. Although late in responding, the Federal Emergency Management Agency (FEMA),

under the capable leadership of director James Lee Witt, worked tirelessly throughout the summer to get relief supplies and other resources to stricken areas during the height of the flooding.

Government efforts had only limited impact, however, as nothing could be done to alter the weather. Fueled by continuing rain falling on ground that was already saturated, rivers remained at record flood stages throughout the summer and into the fall. From March to September, record flooding occurred along more than eighteen hundred miles of river in nine midwestern states, while another thirteen hundred miles were subjected to significant flood damage. When the waters finally subsided in September and October, thousands of individuals displaced by the floods returned to find homes and businesses that could not be repaired. Many were forced to rebuild farther away from rivers; in fact, in some locations entire communities were relocated on higher ground to prevent them from being wiped out again in future floods. In the aftermath of the flooding, state and federal officials estimated that damages throughout the region exceeded fifteen billion dollars, and more than fifty lives were lost.

SIGNIFICANCE

The short-term effect of the flooding was serious in all nine states in which rivers overflowed their banks. Farmers lost a season of planting, manufacturing industries were temporarily prevented from turning out goods, and many service industries suffered loss of business. The federal government was required to provide billions of dollars in emergency assistance to supplement funds made available by state governments. Nevertheless, many affected by the disaster were dissatisfied with what they saw as slow and sometimes inadequate responses to obvious needs. The U.S. Army Corps of Engineers was required to conduct extensive repair work on levees breached by numerous rivers. A thorough review by federal and state authorities conducted in the months following the flooding uncovered numerous deficiencies in weather forecasting, flood prevention, and emergency preparedness. At the federal level, FEMA revised its procedures for dealing with disasters in the hope of being able to be more responsive to future crises.

The long-term effects on some individuals and communities hit hardest by the flood were decidedly more negative. Because the Mis-

souri and Mississippi rivers had wreaked such havoc on areas in their natural floodplains despite the presence of levees designed to protect these areas, significant arguments over the wisdom of reconstructing homes and businesses in the rivers' natural floodplains led many officials to recommend that funds for rebuilding in these areas be withheld. Congress reexamined its program for providing flood insurance and made significant changes that virtually prohibited those living in flood-prone areas from purchasing coverage. Although some communities eventually managed to rebuild on their original sites, several others were not so fortunate. For example, residents of the town of Valmeyer, Illinois, reluctantly voted to reconstruct their entire town on higher ground in the hope that they could avoid a repeat of the disaster that wiped out businesses and homes that had been in some families for generations.

Laurence W. Mazzeno

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■ MAY, 1994

GENETICALLY ENGINEERED TOMATOES REACH SUPERMARKETS

The field of biotechnology reached a milestone when the Flavr Savr tomato became the first genetically engineered food product available to U.S. consumers.

LOCALE: United States

AGRICULTURAL ISSUES: Disease and health issues; Ecology and environment; Food processing; Genetic engineering; Innovations; Marketing and trade; New crops and food products; Pests and pesticides; Scientific research

KEY FIGURES

David A. Kessler (b. 1951), commissioner of the U.S. Food and Drug Administration

Roger Salquist (fl. late twentieth century), chief executive officer of Calgene, Incorporated

Jeremy Rifkin (b. 1945), author and social activist who directed resistance against genetically engineered foods through the Pure Food Campaign

SUMMARY OF EVENT

In May, 1994, Calgene, Incorporated, marketed the Flavr Savr tomato, the first genetically engineered food made available to consumers in the United States. Development and marketing of the tomato involved eight years of research and testing, \$20 million in costs, and nearly four years of review by the U.S. Food and Drug Administration (FDA). The FDA's "safe" ruling on the Flavr Savr, a test case for the agribiotech industry, signaled the feasibility of marketing other genetically engineered foods that had already been developed and field-tested. Fears concerning the effects of genetically engineered foods on consumer health and the environment generated a storm of protest during this period.

The Flavr Savr differed from other tomatoes in that it had been genetically engineered to ripen more slowly. This gave it a significant

advantage because the tomato could remain on the vine until it had begun to ripen yet be marketed before it deteriorated. Although picked before fully ripe, it reddened naturally, without exposure to ethylene gas, and developed vine-ripened flavor and texture.

In the Flavr Savr, the production of polygalacturonase (PG), an enzyme that causes the pectin in tomato cell walls to break down, had been inhibited through genetic engineering. Scientists had identified the tomato gene responsible for producing PG and had used antisense ribonucleic acid (RNA) technology, discovered in cancer research, to suppress the gene's expression.

Genetic engineering, also known as recombinant DNA (deoxyribonucleic acid) technology, enables scientists to target the specific gene responsible for a plant characteristic and suppress it or supplement it with a gene from a species with which that plant would traditionally be unable to breed. Genes from animals, bacteria, or other unrelated plant species can thus be inserted into plants.

Genes code for the production of enzymes, proteins that cause cellular reactions, through an intermediary called messenger ribo-

Although the tomato is botanically classified as a fruit, it is popularly regarded as a "vegetable" because it is not as sweet as fruits that are eaten as dessert items. In any case, "vegetable" is a culinary term, not a botanical term. (©Darko Plohl/Dreamstime.com)



nucleic acid (mRNA). Protein factories called ribosomes attach themselves to the mRNA and read it in order to assemble amino acids into enzymes. To produce the Flavr Savr, researchers determined the sequence of nucleic acids in the mRNA for PG, then reversed and inserted into the plant cells of the Flavr Savr's parent. This reversed sequence adhered to the mRNA for PG and prevented ribosomes from manufacturing it.

The gene for reversed, or antisense, mRNA was inserted into the tomato's DNA through plasmids, circular structures of DNA from a bacterium called *Agrobacterium tumefaciens* (*At*). A marker gene, from another bacterium that confers resistance to the antibiotic kanamycin, was incorporated into the tomato cells along with the gene for antisense mRNA to flag the tomato cells that had integrated the antisense mRNA gene into their DNA. When the cells were exposed to a medium containing kanamycin, cells without the antisense mRNA and accompanying kanamycin resistance from the marker gene died. The resistant cells survived and generated tomato plants capable of suppressing PG.

The Flavr Savr was controversial because it contained a marker gene from a bacterium that made it resistant to the antibiotics kanamycin and neomycin. Some people feared that eating antibiotic-resistant tomatoes would make them resistant to these antibiotics during illness. Others feared allergic reactions to the protein generated by the marker gene.

Calgene, a biotechnology agribusiness founded in Davis, California, in 1980, saw the potential for substantial profit from the vine-ripened tomato market and began developing the Flavr Savr in 1982. From 1987 to 1992, Calgene conducted premarket testing on the Flavr Savr. To reassure consumers, who were becoming increasingly uneasy about genetically engineered foods, Calgene asked the FDA to examine its test results and rule on the safety of the tomato variety. Agricultural plant products, whether produced by genetic engineering or traditional plant breeding, are regulated by the FDA under the guidelines of the Federal Food, Drug, and Cosmetic Act of 1938 and the 1958 Food Additives Amendment to that act.

In May, 1992, under increasing pressure to clarify its position on the regulation of genetically engineered foods, David A. Kessler, commissioner of food and drugs for the FDA, released a document ti-

titled *Statement of Policy: Foods Derived from New Plant Varieties*. In the report, Kessler stated that because the FDA was not aware of any data demonstrating that foods created through genetic engineering present any greater safety concern than traditionally developed foods, the FDA would regulate all food products on the basis of their individual characteristics, not their mode of origin. Furthermore, the producer is legally responsible for ensuring that a food product is safe. The FDA would require premarket testing and labeling of new foods only if they contained lowered concentrations of the important nutrients for which the food was widely consumed, if they had toxic concentrations above an acceptable range, or if unexpected allergens were present.

The FDA's refusal to regulate or label genetically engineered foods evoked a storm of protest from organizations such as the Environmental Defense Fund (EDF) and the Pure Food Campaign (PFC). The EDF proposed that genetically engineered foods be subject to premarket safety testing, that such products be labeled, and that manufacturers be required to notify the FDA at least ninety days before marketing the new foods. Jeremy Rifkin of the PFC was the Flavr Savr's most vigorous opponent. In 1992, he organized fifteen hundred chefs, numerous independent grocers, and some large grocery chains to boycott genetically engineered foods.

In November, 1990, Calgene requested that the FDA issue an advisory opinion on the use of the marker gene in tomatoes. The FDA ruled it safe. In October, 1991, Calgene requested that the FDA issue a separate advisory opinion on the status of the Flavr Savr tomato as a whole food subject to the same regulation as other tomato varieties. Calgene also made the results of its premarket testing available to the FDA and to the public through the dockets branch of the FDA.

Disturbed by the public outcry following the May, 1992, FDA statement regarding its regulatory policy for genetically engineered foods, and realizing that successful marketing of the Flavr Savr depended on public acceptance, Calgene filed a food additive petition for the selectable marker gene with the FDA on January 4, 1993. This is the most stringent safety test that the FDA applies to a food.

In April, 1994, Calgene published the FDA's review of Calgene's data on the Flavr Savr, which concluded that the tomato had not been significantly altered, that the marker gene could not transfer

antibiotic resistance to other organisms, and that the marker did not possess any of the characteristics of allergenic proteins. Also in April, the FDA's Food Advisory Committee undertook a discussion of the safety review of foods produced by new biotechnologies, with the Flavr Savr serving as the discussion's focus. The FDA issued a food additive regulation on the marker gene in May, 1994.

The Flavr Savr was marketed at the end of May, 1994, in the Midwest and in California. Calgene voluntarily labeled the tomato and provided in-store displays explaining its origin. It was reported to have sold out where offered.

SIGNIFICANCE

The Flavr Savr tomato was the test case for the industry; its successful transit through the regulatory process and subsequent marketing ushered in an era of genetically engineered agricultural products. Marketing of these products was expected to result in enormous profits and growth, over time, for the agribiotech industry. Public pressure on the FDA to increase its regulatory oversight of genetically engineered food products continued, as did the debate between producers of genetically engineered foods and those who feared adverse environmental effects.

By 1994, more than thirty genetically engineered agricultural products had been developed and field-tested and were waiting to be marketed; numerous others were in various stages of development. Products expected to move into the market during the 1990's included crops resistant to specific herbicides, viruses, fungi, drought, frost, salinity, and insects. Also in development were crops with superior food-processing traits such as longer ripening time or higher starch content, grains with the full complement of amino acids required by humans and domestic animals, healthier vegetable oils, and biodegradable plant substitutes for petroleum products such as motor oil.

Surveys indicated that although 70 percent of the American public was not opposed to genetically engineered foods, people favored labeling of these products as well as review of them by the FDA. The presidential administrations of Ronald Reagan and George H. W. Bush had been reluctant to create specific regulations for the biotech industry, which they hoped would dominate international markets.

They believed that the industry could be regulated under existing laws created in earlier times for more traditional products.

Bill Clinton's presidential administration adopted a more aggressive stance, not by drafting new laws but by promising to improve coordination of the regulatory efforts of the FDA, the U.S. Department of Agriculture, and the Environmental Protection Agency regarding the industry. As a result of continuing pressure to inspect and label genetically engineered foods, the FDA promised to hold hearings on the issue in 1994 but warned that it would not reverse its position and require a full, premarket review of each new food, nor would it require broad labeling.

Environmental organizations, organic farmers, and scientists outside the biotech industry continued to express various concerns over the ecological effects of genetically engineered plants and urged extreme caution in introducing new plant species. They acknowledged that genetic engineering could be an extremely beneficial technology but pointed to the harm done by other new technologies, such as atomic energy and the insecticide dichloro-diphenyl-trichloroethane (DDT), which were implemented before their full effects were known.

In general, concerns centered on the fact that all elements of the environment exist in sensitive balance with one another. This balance is disrupted and existing elements evolve or are eliminated when a new element is introduced. There is no way to predict all the effects of introducing a new gene into a plant species or of introducing that plant into the environment. Laboratory tests are inconclusive in revealing all possible effects of genetic engineering because the environment cannot be simulated in a laboratory, and field testing poses the danger of releasing organisms into the environment that may affect it negatively and irreversibly.

The agribiotech industry claimed that the new plant species were the basis for a new, more ecologically sound agriculture. Many opponents, however, viewed genetically engineered plants as a temporary solution to serious, long-term environmental mismanagement or as a potential source of continued misuse. Environmentalists were alarmed by the industry's concentration on the development of crops engineered to tolerate herbicides. They believed that they had been betrayed because the new technology had been used to in-

crease dependence on herbicides rather than to develop products and practices that would make herbicides unnecessary.

Insect-resistant crops engineered to contain a gene-producing toxin isolated from *Bacillus thuringiensis* (*Bt*), an environmentally safe pesticide, came under criticism. Insects evolve rapidly to develop resistance to pesticides to which they are repeatedly exposed. There was concern that plants would have to be sprayed with chemical pesticides when insects developed resistance to *Bt*. Organic farmers have used *Bt* as a major weapon in a limited arsenal to control insect damage to their crops, and many were disturbed by the prospect of needing a new weapon.

Gene transfer of engineered characteristics from crops to related weeds was also an issue. The transfer to weeds of resistance to drought, salinity, frost, bacteria, fungi, viruses, herbicides, and pesticides would make them more competitive with both crops and noncrop plants in the environment. Hardier weeds would be more difficult to manage, perhaps requiring stronger herbicides than those currently in use, and might outcompete other species of noncrop plants, diminishing species diversity.

Linda Sims Anderson

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■ 1995-1998

MISMANAGEMENT OF AGRICULTURE BRINGS FAMINE TO NORTH KOREA

Rigid government control intensified by a series of catastrophic calamities brought on a famine of epic proportions in North Korea during the mid-1990's. Despite a worldwide aid response, Premier Kim Jong Il failed to implement necessary structural changes to prevent future crises from occurring in his country.

LOCALE: North Korea

AGRICULTURAL ISSUES: Drought; Famine and hunger; Flooding; International food relief; Natural disasters; Subsistence agriculture

KEY FIGURES

Kim Jong Il (b. 1941), leader of the Democratic People's Republic of Korea beginning in 1994

Kim Il Sung (1912-1994), premier, 1948-1972, and president of the Democratic People's Republic of Korea, 1972-1994

Kim Young Sam (b. 1927), president of the Republic of Korea, 1993-1998

SUMMARY OF EVENT

The emergence of Kim Jong Il as premier of North Korea after the death of his father, Kim Il Sung, in July of 1994 marked the first time a change in leadership occurred in the country since the promulgation of the Democratic People's Republic of Korea (DPRK) in 1948. Unfortunately, however, the effects of the sixty-year dictatorship of father and then son had precipitated negative economic growth since 1989. In 1995, severe flooding weakened an already vulnerable economy and hastened a devastating famine that killed between 900,000 and 2.4 million people, threatening to topple the socialist state.

Although flooding was the immediate catalyst of famine in North Korea during the mid-1990's, it was not the sole cause of the crisis. The state's traditional isolation from the world's healthiest economies resulted in its limited economic base, ultimately rendering it vulnerable to internal and external forces.

In keeping with his party's adoption of economic self-reliance, the elder Kim had encouraged his country to grow subsistence crops such as maize, potatoes, rice, and other essentials to discourage exporting from the global economy. (North Korea, however, never attained complete financial independence, as it relied heavily on the Soviet Union and Communist China.) Ironically, rampant malnutrition followed after Kim Il Sung's relentless drive to achieve self-sufficiency, which resulted in the overuse of North Korea's prime land (only 1.85 million hectares of arable land exists, with a short growing season that lasts from June to October). Additionally, farmers utilized chemical fertilizers, which further depleted the already taxed soil. The net result yielded worrisome food shortages even before the flooding of 1995.

Appealing to the national will, Kim Il Sung in 1991 announced that his people should consume two meals a day in the name of patriotic self-reliance. Despite his call for solidarity, food riots resulted two years later. North Korea's state distribution system, in operation prior to the crisis, had been required to provide 600-700 grams of food for the average citizen. The military and state officials were allotted additional grams because of their status. Nonetheless, as the 1990's progressed, food quotas were rarely, if ever, met, and many trekked to China, desperately searching for food.

Compounding an already unstable economic situation, China, North Korea's primary trade partner after the fall of the Soviet Union in 1991, severely limited its foreign exchange and further demanded hard cash for its exports. With a weak economic base and a falling food supply, North Korea could not meet China's demands and faced almost certain economic ruin.

In July, 1995, severe flooding rocked the already precarious economic environment in North Korea when twenty-three inches of rain flooded premium North Korean soil; the northwest provinces of North P'yŏngan and Chagang were especially affected. An estimated 15 percent of all land destroyed was considered to be of the highest quality. Not only were people malnourished, but also major power outages caused a sharp dip in industrial and agricultural output and adversely affected medical supplies.

In response, individual Korean farmers began to fend for themselves by hoarding grain and concentrating on subsistence rather than communal farming, thereby defeating the ultimate purpose of a

socialist economy. In an unprecedented move that summer, the former Hermit Kingdom sought global resources by petitioning individual countries and U.N. agencies.

Even before the floods hit, North Korea had petitioned Japan and South Korea (the Republic of Korea, ROK) for food. Within a year, however, the ROK's leader Kim Young Sam, who promised to contribute 150 tons of rice, appeared to have a change of heart after his party suffered defeat at the polls on June 27. After his initial delivery of rice, Kim Young Sam not only refused further aid but also discouraged other countries from doing the same. Hoping to unite Korea under his republic, he sought to accelerate the demise of his enemy to the north. The ROK's policy toward North Korea would change in 1998 when Kim Young Sam was ousted from office.

In part, general reluctance to assist the DPRK was a response to the erratic rule of Kim Jong Il, who since his rise to power in 1994 had insulated himself from the citizenry by focusing on a buildup of military forces on one hand and the harnessing of nuclear power for alternate sources of energy on the other—both costly ventures that diverted funds from the needy citizenry. Kim Jong Il's insistence on developing a nuclear reactor in Yŏngbyŏn (north of P'yŏngyang), under construction since 1982, alarmed the international community, which feared that the reactor would place nuclear weaponry in the hands of this unpredictable leader.

Flooding again plagued North Korea in 1996, followed by a drought in 1997, which had severe negative impacts on the resource-rich areas of North P'yŏngan, South P'yŏngan, North Hwanghae, and Kangwŏn—much of whose land had already been adversely affected by two previous years of flooding. By 1997, North Korea was at the center of a grave crisis, and major donors felt compelled to deliver emergency food despite North Korea's belligerent behavior.

The World Food Program and the United States supplied the beleaguered country with much of the aid. (According to Senate hearings conducted before the Foreign Relations Committee in 2003, the United States contributed close to 1.9 million tons of food to North Korea.) However, the North Korean government committed grave injustices by failing to oversee the distribution of aid to its citizenry and in refusing to accept responsibility for famine-related deaths. In many cases, goods were diverted and sold illegally at prohibitive prices

or redirected to the military; unnamed sources estimate that only 10 percent of products donated were given to their rightful recipients.

SIGNIFICANCE

The onset of famine in North Korea brought the once-isolated kingdom into the global arena. Although Kim Jong Il broke with tradition by petitioning the United Nations and individual countries to provide assistance to his people, he failed to ensure the equitable delivery of these materials to those in need. Additionally, Kim Jong Il's emphasis on military preparedness at the expense of his nation's collective health revealed to the international community of nations the character of this despotic ruler who failed to meet the needs of his people.

The historically closed nature of society in North Korea precludes an accurate tally of the fatalities related to the famine. Analysts have concluded, however, that the North Korean government resisted recommended structural changes despite the evidence of inequities that emerged following the famine. It has been reported that North Korea faced more than a decade of steady economic decline. Although the famine officially ended in 1998, the presence of malnutri-



North Korean schoolchildren using hand hoes to plant beans and peanuts near their school for food in April, 1997. (AP/Wide World Photos)

tion in that nation was still widespread during the early years of the twenty-first century.

Debra A. Mulligan

FURTHER READING

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SEE ALSO: 1943-1944: Famine Devastates Bengal; 1972-1973: World-wide Droughts Bring Agricultural Failures and Famine; June, 1982-August, 1983, and early 1997-August, 1998: El Niño Weather Devastates Pacific Basin; February, 2000: Land Reform Ruins Zimbabwean Agriculture.

■ MARCH 20, 1996

BRITAIN ANNOUNCES HUMAN CASES OF MAD COW DISEASE

During the mid-1990's, unusual forms of Creutzfeldt-Jakob disease, a type of spongiform encephalopathy, began to appear among young persons in England. The outbreak of what was later termed "mad cow disease" was traced to beef contaminated with a bovine form of the disease-causing agent.

ALSO KNOWN AS: Bovine spongiform encephalopathy

LOCALE: England

AGRICULTURAL ISSUES: Animal husbandry; Cattle keeping; Disease and health issues; Genetic engineering

KEY FIGURES

D. Carleton Gajdusek (1923-2008), American physician and medical researcher who demonstrated the infectious nature of the prion disease kuru

Stanley B. Prusiner (b. 1942), American neurologist and biochemist who uncovered the protein makeup of prions

SUMMARY OF EVENT

The first recognition of what is now known to be a prion disease was in the eighteenth century, when British farmers observed a degenerative disease among sheep in which the animals would scrape their wool off, rubbing themselves raw on fence posts. The disease, dubbed "scrapie" by the English, was demonstrated during the 1930's to be transmissible among the animals.

Initially thought to be a "slow virus disease" of animals, scrapie was not at first associated with human forms of disease. During the 1950's, D. Carleton Gajdusek, a visiting investigator working at the Walter and Eliza Hall Institute of Medical Research in Australia, began an investigation of a neurological disorder/dementia known as kuru among the Fore tribe on the island of New Guinea (the Fore word *kuru* means "shaking"). Gajdusek determined that the disease, found primarily among the women and children of the tribe, was

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passed by the Fore practice of cannibalism. Transmission of the disease to nonhuman primates by inoculation of brain tissue from victims demonstrated the infectious nature of the etiological agent. In subsequent years, a number of similar human dementias, most notably Creutzfeldt-Jakob disease (CJD), were found to be associated with a similar agent.

Microscopic analysis of brain tissue obtained from both humans and other animals stricken by similar illnesses demonstrated a “spongy” appearance resulting from extreme vacuolation (the formation of small spaces in the tissue containing air or fluid). The diseases were termed transmissible spongiform encephalopathies (TSEs). Certain forms of these diseases were shown to be inherited, but most commonly they appeared sporadically among persons in their sixties or older.

During the 1970's, Stanley B. Prusiner at the University of California, San Francisco, began a series of studies on the agent associated with scrapie in animals. At the same time, a similar agent associated with CJD in humans was likewise undergoing study. Prusiner's data increasingly suggested that the infectious agents lacked any evidence for genetic material composed of nucleic acid. In 1982, Prusiner termed the agent a “prion” (PrP), or “proteinaceous infectious substance.” Prusiner's hypothesis that the agent lacked nucleic acid went against the core of geneticists' belief that only deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) would allow transmission and replication of an infectious agent.

Although Prusiner's suggestion did not achieve universal acceptance, the overwhelming consensus has been that he was correct. Indeed, for their work in prion research, Gajdusek and Prusiner both received the Nobel Prize in Physiology or Medicine, Gajdusek in 1976 and Prusiner in 1997.

Prusiner and Charles Weissman later collaborated on cloning the cell gene that encodes the prion. The normal function of the cell prion, dubbed PrPc, is unknown. The agent itself is made entirely of protein, a chain of some 231 amino acids prepared from a larger precursor. Mutations in the amino acid sequence alter the shape of the protein, which is key to its ability to cause disease. When the mutated agent enters a cell, it twists or transforms the shape of the normal PrPc, resulting in degeneration and death of the infected cells and,



Cow afflicted with bovine spongiform encephalopathy, or “mad cow disease,” which causes progressive degeneration of the nervous system. (USDA/APHIS/Art Davis)

eventually, the organism. The particular site of the mutation determines the form of disease the TSE will exhibit.

The presence of a prion disease in cattle, termed bovine spongiform encephalopathy (BSE), was observed in Europe during the 1980's. This development was probably the result of changes in the ways feed for animals was produced. It had long been common practice to use ground-up animal carcasses in cattle bonemeal, but prior to the mid-1980's, the bonemeal had been subjected to solvent extraction followed by heating at 70 degrees Centigrade for eight hours, a practice that destroyed the scrapie (PrPsc) agent. Changes in the process allowed the scrapie agent to survive and resulted in infection of the cattle that ate the bonemeal. The actual source of the BSE outbreak was never determined. Whether it originated from a spontaneous case of BSE, an admittedly rare phenomenon, or from the ingestion of material from scrapie-infected sheep is unknown.

BSE, which became known as “mad cow disease” in the popular press, was first recognized in Great Britain in 1986. Approximately

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one hundred animals were known to be involved at that time. The extent of the disease within the cattle industry was unknown, but the evidence even then was that the disease was more widespread in cattle than was initially apparent. As a result, the use of protein obtained from sheep or other animals in cattle feed was banned. The outbreak of BSE was a serious blow to the British cattle industry, as consumption of beef dropped steeply in what had always been a beef-eating population.

The first evidence that BSE might pass from cattle to humans appeared in 1994 and 1995 with an increase and change in the demographics of CJD. CJD typically appears in older persons; it rarely develops in persons under age sixty-five. In 1994 and 1995, however, a variant of CJD was observed in ten younger persons, nine of whom were under age thirty-five. The brains of those who subsequently died from the variant CJD demonstrated large protein deposits typical of TSEs but not commonly found in classical CJD. On March 20, 1996, the British government released a report that conceded that the variant form of CJD was likely the result of the victims' having eaten contaminated meat.

Confirmation of the link between the variant CJD in humans and BSE in cattle was provided in October of 1996. John Collinge of the Prion Disease Group at Saint Mary's Medical School in London reported the results of a "fingerprint" analysis comparing the proteins of BSE and variant CJD in which the proteins were shown to be effectively identical. The infectious nature of the human agent was also shown the following year, when scientists used infected human brain tissues to transmit the disease to mice. The lesions that developed in the brains of the infected mice were identical to those in the human brains, confirming the likely source of the variant disease.

Although the number of new cases of variant CJD continued to increase in subsequent years, the rate of increase leveled off. By 2006, approximately 150 cases of variant CJD had been diagnosed in Great Britain. Not surprisingly, the average age of the victims had increased, with some cases developing in persons in their mid-fifties.

SIGNIFICANCE

Recognition that the BSE agent could pass from cattle to humans resulted in a ban on the use of bonemeal from diseased animals in ani-

mal feed. Further, diseased cattle could no longer enter the human food chain. Strict enforcement of these rules was successful in preventing transmission of CJD from cattle to humans in the United States. Vigilance, of course, remains necessary, and occasionally meat from a “mad cow” has managed to enter the food chain. There has been no evidence for any human disease associated with these animals, however.

Long-term effects of the BSE outbreak in Great Britain may remain unknown for some time. The total number of persons exposed to the agent was probably in the hundreds of thousands. Given that the incubation period for the CJD agent can be measured in decades, by the early twenty-first century it was not known whether the approximately 150 persons diagnosed with variant CJD by that time would represent the likely total or merely the tip of a disease iceberg.

The ability of the agent to be transmitted through ingestion also raised concerns about similar diseases in other animals. For example, a prion-associated illness known as chronic wasting disease has been observed in deer and elk in the western United States. Although there has been no evidence that the agent has been passed to humans who have eaten animals with this disease that have been killed by hunters, there is still concern that transmission is possible.

Richard Adler

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■ JUNE-OCTOBER, 1997

INDONESIAN FOREST FIRES DAMAGE SOUTHEAST ASIAN AGRICULTURE

In Indonesia, subsistence and industrial agriculturists set fires to expand land available to cultivate food crops and palm oil trees. Because drought conditions existed, fires blazed out of control, burning millions of acres, including rain forests. The large amounts of smoke caused by the fires covered Indonesia and other Southeast Asian countries for several months. Pollutants harmed both humans and animals exposed to the smoke and interfered with trade and travel in the region.

LOCALE: Indonesia; Malaysia; Singapore; Thailand; Vietnam; Philippines

AGRICULTURAL ISSUES: Climate change; Drought; Ecology and environment; Natural disasters; Subsistence agriculture; Tropical produce

KEY FIGURES

Suharto (1921-2008), president of Indonesia, 1967-1998

Djamaludin Suryohadikusumo (b. 1934), Indonesian forestry minister, 1993-1998

Sarwono Kusumaatmadja (b. 1943), Indonesian environment minister, 1993-1998

Syarifuddin Baharsyah (b. 1933), Indonesian agriculture minister, 1993-1998

Datuk Seri Mahathir bin Mohamad (b. 1925), prime minister of Malaysia, 1981-2003

Emmy Hafild (b. 1958), director of the Indonesian Forum for the Environment

Bob Hasan (b. 1931), Indonesian timber plantation investor

SUMMARY OF EVENT

In 1997, Indonesia suffered its worst drought in a half century. The problem was exacerbated by El Niño conditions that altered normal precipitation and weather. During 1997, these conditions delayed



Indonesian rice field. (©Marcvanvuren/Dreamstime.com)

the September monsoon season for two months. Subsistence farmers welcomed the abnormal weather pattern and burned additional land to clear it for crops. This practice was a well-established tradition for survival within Indonesian culture; however, in 1995, national leaders had banned extensive burning because previous fires had interfered with diplomacy and shipping. In 1997, commercial farmers and investors viewed the extra phase of dryness as an opportunity to earn more profits. As a result, beginning in June, immense human-caused forest fires swept through the country.

During the drought, private companies harvested hardwood timber to export. After workers cleared the harvested land by burning brush, landowners planted oil palms—creating plantations tens of thousands of acres in size—to produce oil from palm fruit to be used for a variety of goods. Several thousand acres burned weekly and rain forests in Indonesia became depleted quickly as a result of the agricultural developments. The fires raged uncontrolled—emitting toxins and pollutants in the air—in order for agribusinesses to attain larger plantations to grow more palm oil trees.

Indonesian president Suharto, hoping to profit from the increase in agribusiness, approved burning licenses for business investors

whom he knew. Emmy Hafild, director of the Indonesian Forum for the Environment, strived to stop the excessive burning. She realized the majority of Indonesian politicians were corrupt and eager to accept bribes from land investors. Hafild noted that political conditions provided minimal means to enforce the 1995 burning ban or gain control over land-hungry businesspeople.

Some officials, though, particularly Environment Minister Sarwono Kusumaatmadja, attempted to stop unlawful burning, providing information for the forestry ministry to strip companies of licenses. Publicly stating the fires were an overwhelming disaster, Kusumaatmadja established a group to use satellite images to watch the fires and vowed that anyone setting fires would be penalized. Despite those efforts, palm oil companies continued burning land, realizing Suharto and his supporters would not interfere.

In addition to blaming drought conditions for the fires, Indonesian officials encouraged the media to accuse subsistence farmers and foreigners—specifically Malaysians—for setting the fires and allowing them to expand unchecked. The amount of damage to the rain forest and air, however, was too great and swift for small farmers to have caused. Such rapid, fiery destruction seemed most likely attributable to industrial agribusinesses and influential plantation owners such as Bob Hasan, who owned millions of acres in Indonesia and was a close friend of Suharto. Until smoke obscured the view, satellites verified that companies were burning large areas.

Hasan spoke publicly in support of Suharto. Citing statistics, he emphasized that 49 million hectares of Indonesia's 143 million hectares of forest were located in national park and protected areas. Hasan also stated that 64 million hectares had stipulations that controlled harvesting to a maximum of ten trees on each hectare. He stressed that only 30 million hectares were available for agricultural usage.

Hasan emphasized that forest-related businesses employed four million workers, which aided economic stability. As a result of the fires, Indonesia established the world's largest palm oil orchards; Hassan argued the orchards were industrial resources for workers and communities that eased impoverished conditions. Hasan stated that he encouraged reforesting land and wanted the Indonesian government to sue anyone who burned forests. Despite Hasan's assertions, environmentalists detected that large percentages of money

designated for reforestation were diverted to unrelated projects pursued by Suharto's cronies, including Hasan.

Smoke from the Indonesian fires floated above the South China Sea to Kuala Lumpur, Malaysia, staining the sky gray and yellow and polluting it with noxious odors. Similar problems were not experienced in Jakarta, Indonesia's capital, where air currents diverted smoke elsewhere. Suharto's advisers, in order not to alarm the president, did not report foreign complaints immediately. By September 9, Suharto asked the military to assist in enforcement of the 1995 laws; however, no fines were levied against those who continued to burn land after the October 3 deadline. After Suharto became aware of problems in nearby countries caused by the smoke, he extended a halfhearted apology in mid-September, 1997, passively saying God had created the haze.

Investors worried licenses to clear additional land might be denied and approved the immediate burning of land. Instead of handling the problem decisively, Suharto concentrated on other problems plaguing Indonesia, such as the disintegrating economy and currency devaluation. Syarifuddin Baharsyah, agriculture minister of Indonesia, stated that 173 plantations with palm oil and rubber trees were ablaze. Forestry minister Djamaludin Suryohadikusumo stripped nine businesses of their licenses, claiming they had not provided evidence they no longer burned land. Suryohadikusumo stopped renewal of sixty licenses, but those businesses kept clearing land.

After demonstrators protested the fires, Malaysian prime minister Datuk Seri Mahathir bin Mohamad shifted his attention from economic concerns in late September, 1997, to the deployment of firefighters to Indonesia. In some urban areas, people hosed the smoke from the tops of tall buildings. Some foreign firefighters were used to fight the blazes on the ground, while others dropped water from aircraft.

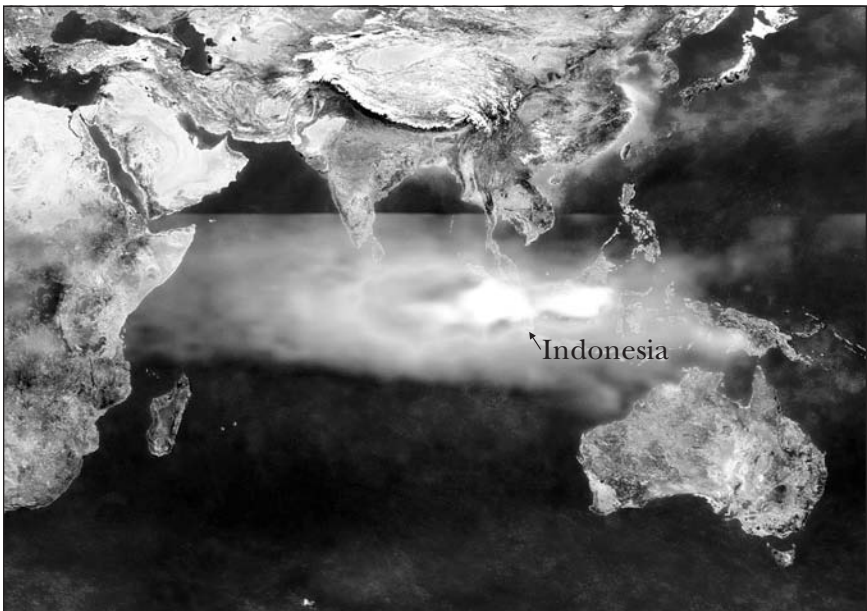
In November and December, rainfall interrupted most fires, although some peat fires smoldered underneath the surface. Indonesian leaders finally created legislation in late 1997, which outlawed people from burning land from July through October. Although almost two hundred companies violated the law, none were held legally accountable. Fires resumed and expanded in February, 1998, and occurred in 1999, also. Laws against burning were ineffective partly be-

cause influential businesses emphasized that commercial agricultural money helped Indonesia's weak economy.

SIGNIFICANCE

Approximately 25 million acres in Indonesian forests burned in 1997. Damages related to the fires totaled \$9 billion. Smoke reached several Southeast Asian countries, complicating diplomatic relations. Malaysian leaders stated that the smoke reduced that country's tourism by 13 percent.

Approximately seventy-five million people, including forty-eight million Indonesians, were affected. Chemical toxins, especially carbons and sulfurs, entered the atmosphere and caused the air pollution index to reach dangerous levels. People suffered from fire-related ailments, included breathing and cardiovascular disorders, and wore masks and carried respirators. Many people could not work and had large medical costs because of the smoke. Wildlife—including endangered species—was significantly affected. Orangutans could not survive in burned habitats.



Composite of satellite photographs showing the extent of air pollution over the Indian Ocean caused by Indonesia's forest fires. (NASA)

Ironically, despite investors' ambitions, smoke hindered growth of trees, interrupted palm oil exportation, and depleted food supplies. The lack of sunlight impeded vegetable growth and reduced bee pollination. Soil erosion affected coral reefs and fish populations. Upset about the destruction of tropical rain forests, environmentalists worried about the fires' long-term damage to the ecosystem, effect on weather, and contribution to global warming.

In 1997, the Association of Southeast Asian Nations (ASEAN) discussed ways to prevent fires in Indonesia. The financial impact of the fires provoked dissension in Indonesia, and Suharto resigned in May, 1998. At the 1999 ASEAN meeting, Indonesian leaders proposed seeding clouds from airplanes to create rain. Scientific studies utilized satellites, radiometry, and remote sensors to consider ways to stop disastrous practices. Traditional farming culture in Indonesia, entrenched political response, and recurrent droughts resulted in most critics realizing obvious solutions could not be easily implemented.

Elizabeth D. Schafer

FURTHER READING

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LAND REFORM RUINS ZIMBABWEAN AGRICULTURE

In 2000, Zimbabwean president Robert Mugabe proposed a referendum to his nation's constitution that would allow the government to seize land without compensation to landowners. In the chaos resulting from implementation of this plan, the productivity of the nation's once-prosperous farms plummeted.

LOCALE: Zimbabwe

AGRICULTURAL ISSUES: Agrarian reform; Government policy and regulation; Land and land policy; Tropical produce

KEY FIGURES

Robert Mugabe (b. 1924), prime minister of Zimbabwe, 1980-1987, and president of Zimbabwe beginning in 1987

Clare Short (b. 1946), British secretary of state for international development, 1997-2003

Kumbirai Kangai (b. 1938), minister of agriculture and development of Zimbabwe

George Foulkes (b. 1942), British undersecretary of state for international development, 1997-2001

SUMMARY OF EVENT

Zimbabwe was once a British colony known as Rhodesia. Although the country gained its independence, the effects of colonialism still remain. In order to reap the full benefits of its colony, Britain redistributed the arable farmland in Zimbabwe and allotted the land to a small group of elite citizens of British descent. As a result of this redistribution, the majority of the Zimbabwean population was left landless and in poverty. The colonial landowners continued to possess the majority of productive land into the twenty-first century.

Despite Zimbabwean independence, the elite white landowners continued to rule the nation. Disagreements among these landowning groups eventually escalated into a civil war. The British government was forced to oversee peace negotiations that culminated in the



Early twentieth century Rhodesian tobacco farm. During Zimbabwe's colonial era, the country was one of the world's leading producers of fine tobacco, but that industry fell into ruins after the country became independent. (Library of Congress)

elections of 1980. Robert Mugabe, the head of the Zimbabwe African National Union (ZANU) party, was elected almost unanimously.

Mugabe's ideology was parallel to African liberationists of the 1960's. He was strong and ruthless, heavily anti-Western, suspicious of capitalism, and deeply intolerant of dissent and opposition. His appeal was anchored by the fact that he was a native of Zimbabwe—not of British descent—and a proponent of major land reform. Mugabe insisted that in order to alleviate the extreme poverty of the majority of Zimbabweans, arable land had to be removed from the hands of the few and redistributed among the masses. His promise to improve the economic situation of Zimbabwe made him a popular leader, but his reign was not without controversy. The nation still required billions of dollars in aid from Britain for economic survival, and there were reports of mass genocide and disappearances of Mugabe's opponents.

As early as 1985, Mugabe's government tried to implement land redistribution policies. In 1985, the Land Acquisition Act allowed the

government to purchase farmland from willing owners to be redistributed among the poor. In 1992, the act was changed to allow the government to purchase land without consent, with farmers receiving a certain degree of compensation. Despite the new policy, very few of Zimbabwe's peasants were actually given land. Mugabe was accused of giving the newly acquired farmland to his supporters instead. This accusation was economically detrimental because it caused Britain, fearing its financial aid was used incorrectly, to cut down on its level of assistance.

Even with the 1985 Land Acquisition Act in place, many landowners refused to cooperate. Frustrated with the inability to redistribute Zimbabwe's land in its entirety and at a fast enough pace, Mugabe's administration proposed that the country's constitution be rewritten. The new constitution would contain a land redistribution policy that elite landowners would be unable to avoid or slow down. This policy required landowners to give up portions of their land at the government's request without any form of compensation. The new constitutional policy appeared on a referendum in February of 2000.



Zimbabweans armed with farm tools converge on a farm seized by the government in April, 2000, to demand the land for themselves. (Alexander Joe/AFP/Getty Images)

The Movement for Democratic Change (MDC), which was composed of landowners and others in opposition to the referendum, defeated Mugabe's proposal. The MDC, along with Western governments that disagreed with Mugabe's land-reform policies, insisted that Mugabe's economic solutions—namely, the seizure of property—worked in the short term but did not create a more sustainable economy for the long term. It seemed that Mugabe's long struggle to redistribute land had been defeated for good. However, a few weeks after the referendum was defeated, members of the ZANU party and other Mugabe supporters began forcibly taking over land that belonged to the elite landowners without support of the law. Beginning in 2000, thousands of white farmers had their land confiscated by Mugabe supporters.

In an attempt to force peasants into rural farming areas, Mugabe instituted a relocation policy known as Operation Murambatsvina, or Operation Restore Order. The purpose of this operation was to bulldoze shantytowns in order to force peasants out of cities and onto farms in rural areas. Hundreds of thousands of people were left homeless due to Operation Murambatsvina. Critics claim that Mugabe instituted this policy to punish people who voted against him in the past. This exemplifies why foreign and domestic critics referred to Mugabe as a dictator and an ineffective, power-hungry leader who was unconcerned about the well-being of his people.

Zimbabwe's struggle for land reform was a pervasive sub-Saharan African dilemma: Many countries throughout the region continued to suffer from similar postcolonial struggles. Global organizations and world leaders agreed that in order to help African countries rise out of poverty, resources and wealth had to be redistributed more equally. However, instead of economically elevating the lower class, fast-paced policies like Mugabe's seemed to bring more poverty.

SIGNIFICANCE

The seizure of white landowners' property caused an economic collapse, as white landowners began fleeing Zimbabwe in large numbers. Out of fear for their safety, landowners cut their losses and took their investments elsewhere. The drop in income that the emigration produced left Zimbabwe—once a huge agricultural producer in Africa—increasingly impoverished through the ensuing decade. The

lack of agricultural production increased extreme poverty and created a society threatened continually by ever-present starvation. By 2009, Zimbabwe was experiencing one of the highest rates of inflation in world history, and the national economy was returning to a barter economy. Calls for Mugabe's ouster became almost universal, but Mugabe himself continued to respond to criticism by claiming that foreign governments—namely, the United Kingdom and the United States—were sabotaging the Zimbabwean economy as punishment for his strict land-reform policies.

Jennifer L. Titanski

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■ JULY, 2002

GENETICALLY MODIFIED SEEDS TAINT NEW ZEALAND CORN EXPORTS

*In his 2002 book *Seeds of Distrust*, journalist Nicky Hager alleged that genetically modified corn had been illegally released in New Zealand. He further alleged that Prime Minister Helen Clark and her government knew about the release and covered it up. These revelations and the failure of the government to deal forthrightly with the issue diminished the popularity of the Labour government. Of even broader importance, the scandal seemed to indicate that it may no longer be possible to keep agriculture completely free of genetically modified produce.*

ALSO KNOWN AS: Corngate

LOCALE: Wellington, New Zealand

AGRICULTURAL ISSUES: Botany; Diet, nutrition, and cuisine; Food processing; Genetic engineering; Government policy and regulation; New crops and food products

KEY FIGURES

Nicky Hager (b. 1958), New Zealand writer and investigative reporter

Helen Clark (b. 1950), prime minister of New Zealand, 1999-

John Campbell (b. 1964), New Zealand television broadcaster

Jeanette Fitzsimmons (b. 1945), member of the New Zealand parliament and Green Party leader

Marian Hobbs (b. 1947), member of the New Zealand parliament and minister of the environment, 1999-2005

SUMMARY OF EVENT

Agricultural products are sources of great national pride in New Zealand and are essential to the island nation's economy. The "naturalness" of New Zealand produce is a primary aspect of the products' appeal on world markets. To maintain that appeal, the country has extremely stringent regulations that prevent the introduction of genetically modified (GM) organisms for commercial purposes. Even the accidental introduction of GM plants would devastate the country's carefully crafted image and potentially hurt the economy.

In early July, 2002, New Zealand investigative reporter Nicky Hager's book *Seeds of Distrust: The Story of a GE Cover-up* was released only a few weeks before parliamentary elections. Hager alleges in the book that in September and October, 2000, 5.6 tons of sweet-corn seed were shipped to three New Zealand companies. These seeds had been imported from the U.S.-based company Novartis, the second-largest seed producer in the world, and were certified to be free of all genetically engineered modifications. In total, 164 hectares (405 acres) of these corn seeds were planted in the regions of Hawke's Bay, Gisborne, and Marlborough, New Zealand.

Hager further alleged that in November, the New Zealand government was alerted that a 1.7-ton lot from this shipment, designated NC9114, went to Cedenco Foods, which retested the sweet-corn seed for GM contamination. Of the eight seed lines tested, one batch tested positive for the Nos terminator, a sequence not found in healthy plants but in the soil bacterium *Agrobacterium tumefaciens*. *Agrobacterium* is a plant pathogen that transfers some of its genes into plants and causes the plant tissue to form a crown gall that overproduces unusual amino acids called opines, which only *Agrobacterium* can metabolize. Plant geneticists have exploited this ability to make engineered strains of *Agrobacterium* that can introduce exotic genes into plant genomes. The presence of the Nos terminator in a plant seed genome is an indication that the plant is a GM plant. Novartis informed New Zealand's ministry of agriculture and forestry (MAF). The MAF and the environmental risk management authority (ERMA) ordered that no more seeds from this consignment be planted.

Further tests were ordered from three different labs, but the results were contradictory, ranging from light contamination to none. In December, 2000, ERMA stated that the contradictory results did not provide definitive evidence that the sweet-corn seed consignment was contaminated with GM seeds, and if there was contamination, it was less than 0.04 percent. Unfortunately, the New Zealand Hazardous Substances and New Organisms Act specified that no GM organisms could enter the country for commercial use. Prime Minister Helen Clark initially wanted the GM-contaminated plants pulled out and burned. However, after meetings with representatives from Novartis, Clark and her ministers changed their minds. The Novartis



Members of Greenpeace waiting to confront New Zealand prime minister Helen Clark in Auckland in on July 20, 2002. "Clarkie's" is a play on the prime minister's name. (Dean Purcell/Getty Images)

representatives convinced them that GM plants are ubiquitous and therefore completely GM-free seed shipments were neither practical nor possible. Thus, the Clark government considered a contamination level below 0.5 percent to be virtually GM-free. The seeds from the GM-contaminated consignment were allowed to be grown, harvested, and processed into food products. This also violated the government's own moratorium on the release of GM crops, which was not set to expire until October, 2003. More important, all of this was done with little or no public disclosure.

With the publication of Hager's book, Clark and her government ministers came under increased public pressure to answer Hager's allegations. In a July 10, 2002, television interview with broadcaster John Campbell, Clark responded angrily when asked about the claims made in Hager's book. She called Campbell "a little creep," accused the television station of ambushing her, and appealed to the broadcasting standards authority to discipline Campbell for unethical journalism.

Upon hearing about an apparent government cover-up that al-

lowed GM plants into the country, the Green Party, which up to this point was a close political ally of the Labour Party, criticized the Clark government for violating its own policies on GM plants. Again, Clark responded by attacking the Green Party coleader, Jeanette Fitzsimmons, saying that the "Green Party and its supporters have descended to the gutter."

Even more troubling were the constant denials by government ministers that GM plants had entered the country. For example, in a July 11 interview with Campbell, the minister of the environment, Marian Hobbs, stated that there were no definitive tests that showed that the corn-seed shipment had been contaminated. Two days before, Clark also stated there was no evidence that the corn shipment was contaminated. The press named this scandal "Corngate."

The 2002 election was not a disaster for the Labour Party, but the party did fail to gain a clear majority. The government released seven hundred pages of memos, e-mails, and other documentation, and in November, a select committee was formed to investigate the matter. After examining stacks of official documents and interviewing government officials, the committee could not reconcile the discrepancies between the oral reports given by Labour government officials and the written records provided to the committee. Furthermore, Novartis, now known as Syngenta, refused to share data from the tests it and others had run on the contaminated seed shipment.

The inquiry, however, did reveal that Clark did not leave the issue to her ministers, as she had strongly intimated, but was involved in the entire affair. Suppressed memos that were damaging to the Labour government's version of events also came to light, as did several conflicts of interest. Even though the country was largely tired of Corngate by this time, the findings of the select committee tended to show that the Labour government altered the truth.

On July 5, 2003, the *Dominion Post*, a Wellington-based newspaper, reported that a Japanese pizza company discovered genetically engineered material in one of its toppings that used New Zealand sweet corn. This indicated that GM corn was established in New Zealand farms, despite the government bans on GM plants.

In October, 2004, the select committee completed its investigation but was still unable to ascertain what had actually happened. The

presence of GM-contaminated corn or a cover-up could be neither ruled out nor confirmed. After that date, GM plants were detected in New Zealand fields and imports and food products.

SIGNIFICANCE

The Corngate scandal opened a seemingly permanent chasm between New Zealand's Labour and Green parties. Despite the center-left political orientation these two parties hold in common, Corngate revealed the irreconcilable differences between the two parties on the issue of GM plants.

Corngate also marred the otherwise excellent political record of Prime Minister Clark. Normally level-headed and reasonable, Clark often lost her composure when questioned about Corngate. In many ways, Corngate struck at the very substance of Clark's government, since it looked like a murky compromise of principles in the face of pressure from industry, causing citizens who had once trusted her to become suspicious. Overall, Clark's Labour government handled the scandal quite poorly but did not suffer greatly in the end.

More important, this scandal exposed the complicated and multifaceted issues that surround the planting and harvesting of GM food plants. Because of the widespread use of GM plants, it is no longer possible to keep agriculture completely GM free. Establishing a total absence of GM seeds would require testing every available seed, which would leave none to plant or eat. Accepting low levels of GM contamination is probably the most realistic policy, even if it is not the most desirable. Communicating this idea to a public with a poor knowledge of such matters is difficult, but it may be the only way to cultivate a reasoned discussion of this issue and eventually to construct rational and workable GM policies.

Michael A. Buratovich

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